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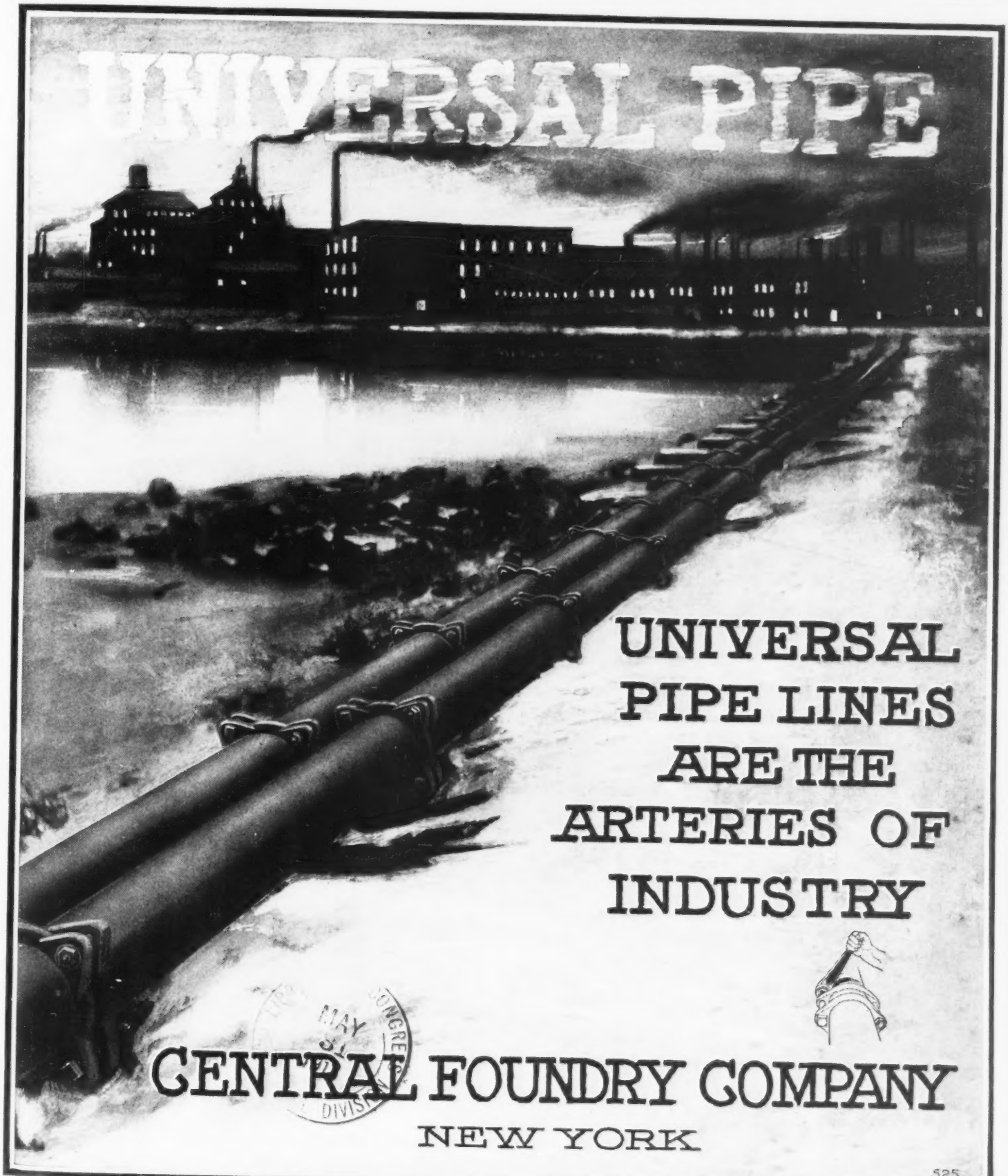

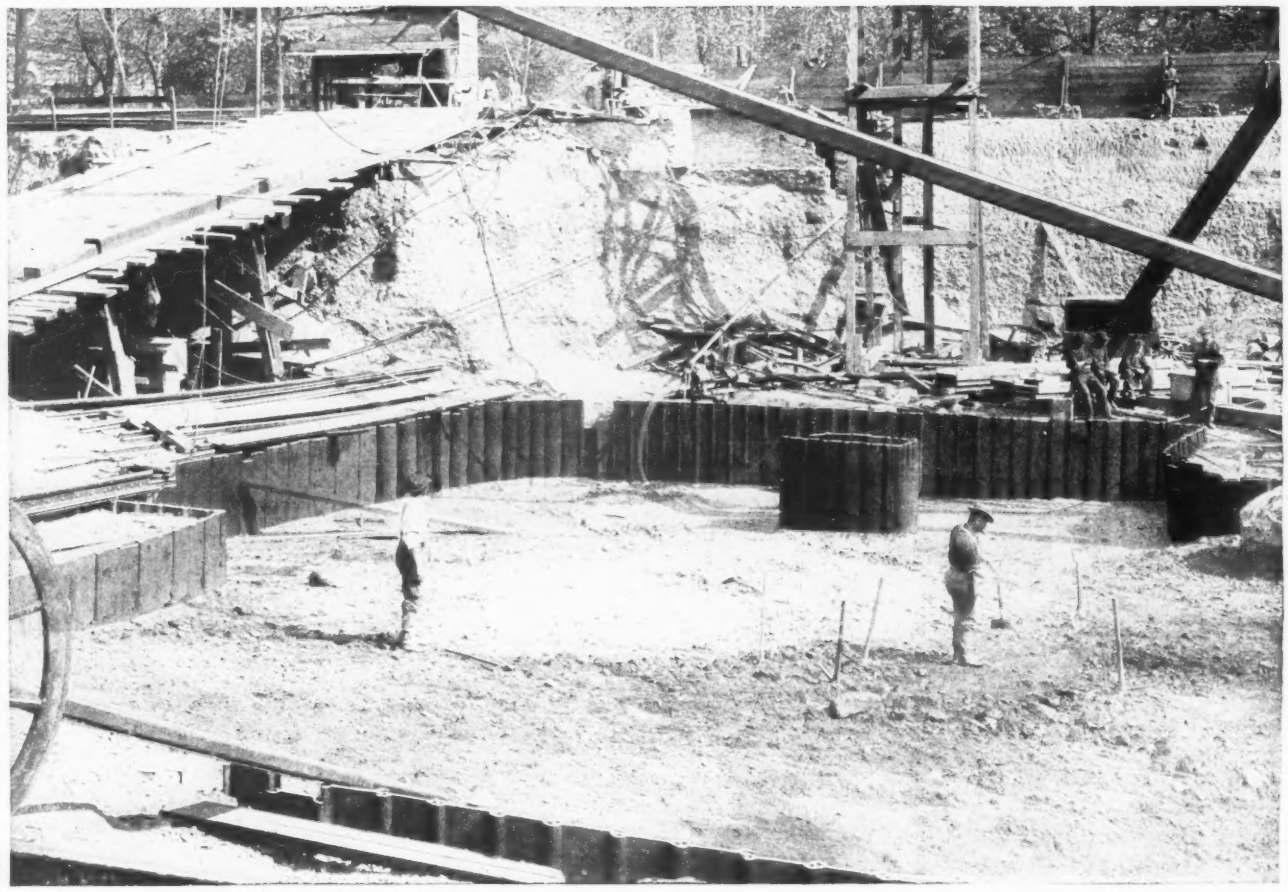

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Engineering News

CHARLES WHITING BAKER, *Editor*

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Engineering News

VOLUME 69 MAY 29, 1913 NUMBER 22

The Yardley Bridge across the Delaware River, Philadelphia & Reading Ry.

The Philadelphia & Reading Ry. Co. has just completed near Yardley, Penn., one of the largest two-track concrete railway bridges in existence. This bridge is located on the line of the New York division between New York and Philadelphia at the crossing of the Delaware River, and replaces an old wrought-iron deck truss bridge, which has been in use since 1876.

The old bridge consisted of two 60-ft. deck plate-girder spans and seven wrought-iron deck trusses, one 120 ft., one 170 ft., and five 200 ft. in span. It had trusses 26 ft. 8 in. in depth, and a rail elevation some 70 ft. above the river. This bridge was erected in 1875 and opened for service in May, 1876. It was built jointly by the North Pennsylvania R.R. Co. and the Delaware & Bound Brook R.R. Co., F. H. Saylor being chief engineer and the late D. McN. Stauffer, for many years Editor of ENGINEERING NEWS, resident engineer. The masonry was built by McGranus & Fitzpatrick, and J. H. Cofrode & Co. were the contractors for the iron work. It was strengthened in 1883 by the introduction of an additional middle truss, adding 50% to the strength of the trusses and 100% to the floor system.

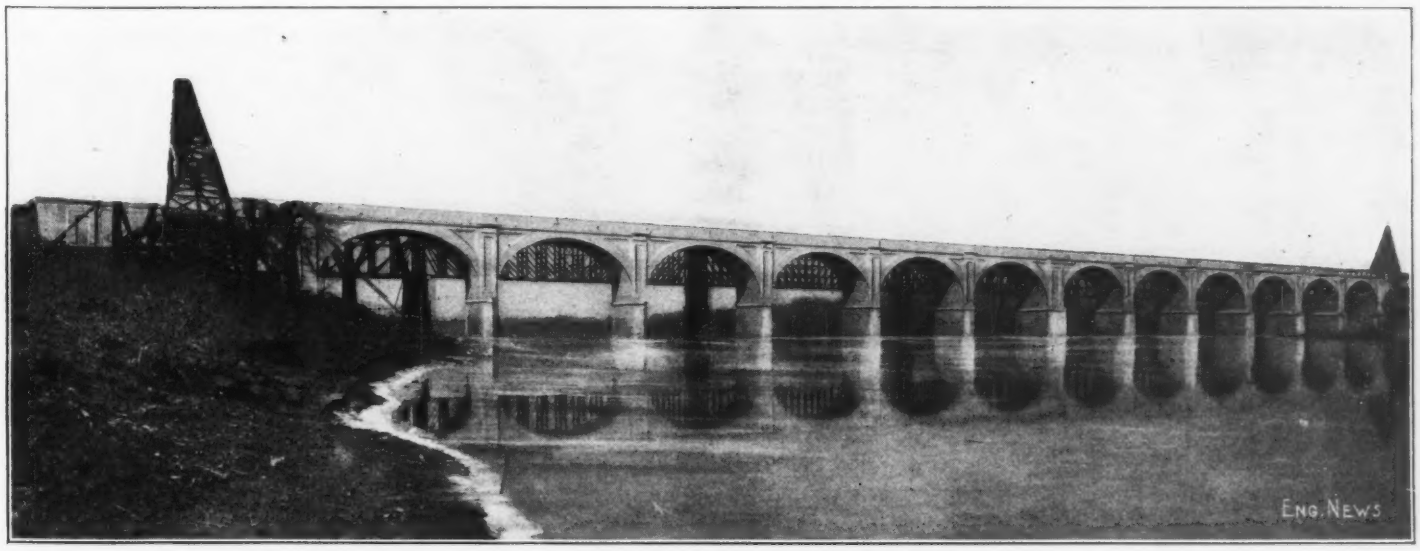


FIG. 1. VIEW JUST BEFORE COMPLETION OF PHILADELPHIA & READING R.R. BRIDGE ACROSS DELAWARE RIVER, AT YARDLEY, PENN.
(Old iron truss bridge in background.)

DESIGN

The new bridge parallels the old, with center lines 35 ft. apart, connection to the main-line tracks being made by easy curves about one thousand feet back from the abutment of the bridge. The new bridge has a total length between ends of abutments of 1445.5 ft. and is made up of 14 arches, 11 of which are 90 ft. 9 in. in clear span, and three 85 ft. 11 in. clear span. The structure is divided in two by a middle abutment pier 20 ft. in width, whereas the intermediate piers, which are stable only under balanced dead load, are 10 ft. in width. There is a rising grade to the eastward of 0.22 ft. every 100 ft. The bridge carries two tracks 13 ft. c. to c., and is 33 ft. wide from out to out of coping. The base of the rail is about the same elevation as the old bridge, that is, 70 ft. above low water in the river, and about 80 ft. above the bed rock.

This bed rock is found very close to the river bottom and was utilized in all piers and abutments for a foundation. As originally designed, the two end abutments were to rest on concrete piles, but as described hereafter this project was abandoned and the abutments were carried to rock.

The piers are solid plinths resting as before noted on bed rock, and having plans symmetrical about a longitudinal center line. Each pier is provided with a cutwater extension. The upstream noses of Piers 2 to 11 inclusive are protected by bent steel plates 18x½ in. thick, anchored to the pier by ¾-in. round bolts. The side and end faces of the piers have a batter of ½ in. to the foot. The lower section is capped by a coping course 11 ft. wide and 2 ft. thick, the top of coping being about 4 ft. below the springing line of the arch.

Below the arch spring the abutments are solid plinths similar in section to the piers and extending as the piers to solid rock. The side walls, which extend up as spandrels above the arch spring, have an overhang to the rear, which overhang carries the railing back from the main pedestal of the abutment. The earth fill tails down alongside of the abutment and is held by low toe walls.

The arch ribs are full-width reinforced-concrete rings, curved to a five-centered arch. They are reinforced with two lines of reinforcing rods, one at the intrados and the other at the extrados, each being of ¾-in. square twisted rods spaced 7 in. c. to c. These are tied together with transverse rods ½ in. square and spaced 3 ft. c. to c., but are not connected with rods in a vertical plane. The arch rib is peculiar in one respect, in that its actual thickness is greater than its showing thickness. As will be noted from the halftones and from the elevations of the arch in Fig. 2, the showing face of the arch rib is 3 ft. 6 in. deep at the crown, enlarging to a radial depth of about 7 ft. at the springing line. In reality, the arch rib is 3 ft. 6 in. deep at the crown, but enlarges at a much greater rate to a depth of about 13 ft. 6 in. at its juncture with the adjoining arch over the middle of the pier. The reinforcement, however, follows the real depth, not the showing depth, of the arch, as shown on Fig. 2.

In erecting the arch the showing face depth was built first and the extra depth placed after the arch centers were struck. It will be seen from Fig. 2 that the arch rib as first built to the showing thickness carries on its top a section equivalent to the difference between the showing depth and the real depth, and that this section is tied into the showing arch rib when it is completed by roughening steps left in the extrados of the showing arch. A view looking down on one of the showing arches is given in Fig. 4, showing the roughened surface preparatory to receiving the additional arch rib section. This additional section extends only to within 2 ft. 6 in. of the outer edges of the rib, this 2 ft. 6 in. space being filled with the vertical spandrel walls, which are thus on the showing faces continuous from the showing arch ribs to the coping of the railing. The spandrels are tied into the upper part of the rib with anchor bolts (Fig. 2).

These spandrel walls are of gravity section and solid throughout. They have between them a fill made up of one- and two-man-size stones, which are carried to the subgrade of the roadbed where the regular ballasted roadbed is laid.

The pilasters are carried up above the base of the rail about 5 ft. and extend behind the face lines of the arches, providing refuge bays at the track level, and together with the intermediate concrete posts and two lines of 4-in. galvanized iron pipe form the railing.

Expansion is provided in each arch by vertical construction joints in the spandrel walls, rising as shown in Fig. 2.

The waterproofing of the arches is composed of five layers of felt, protected by one layer of hard brick thoroughly mopped, applied to the tops of the arches between the spandrel walls and flashed up in the inner faces of the spandrels about 12 in., except directly over the pier where the flashing extends 4 ft. above the tops of the arches. All vertical expansion joints and horizontal construction joints are protected by a single layer of prepared burlap 12 in. wide thoroughly mopped with an asphalt compound. This burlap is carried under the coping in all expansion joints.

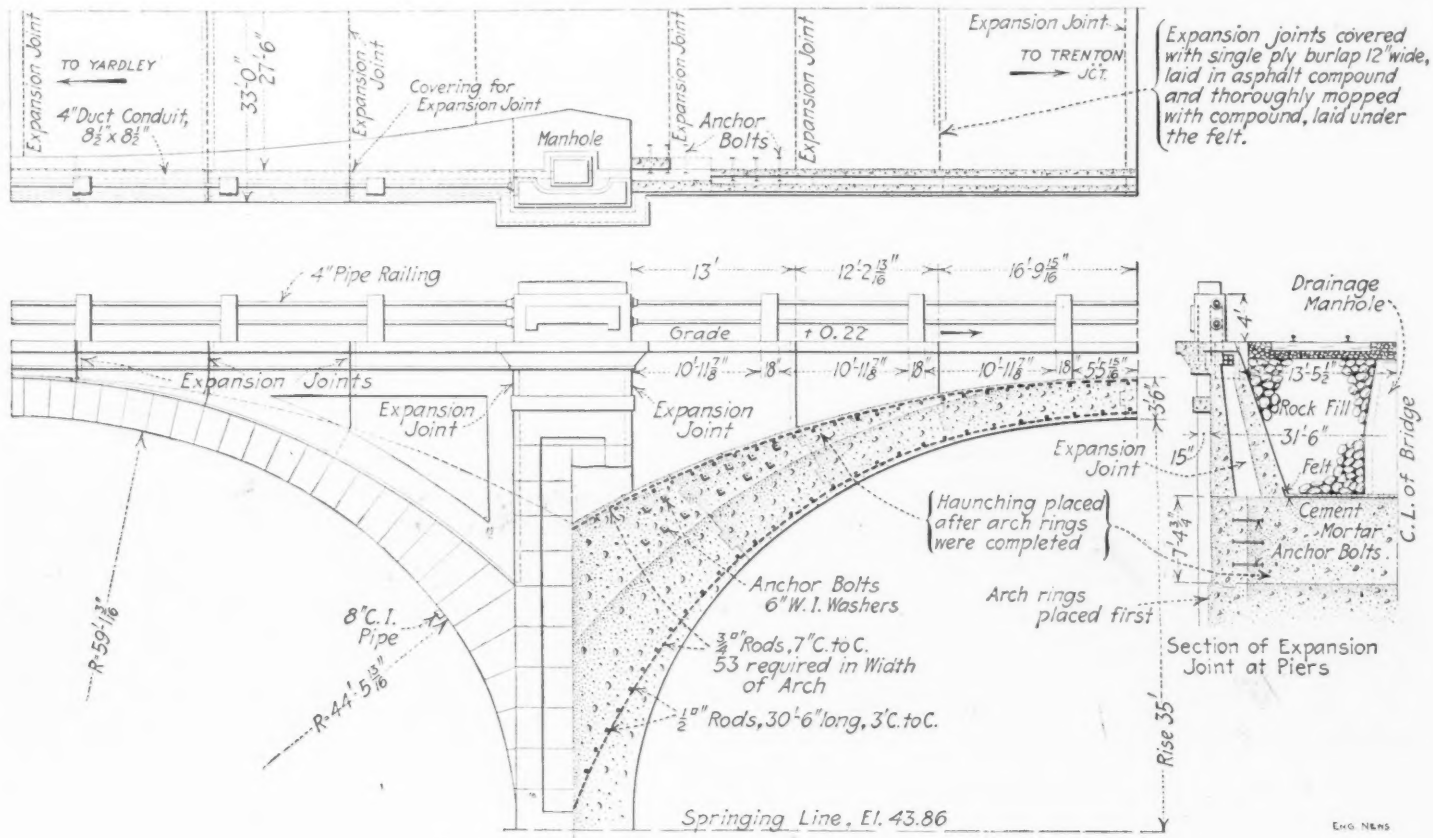


FIG. 2. DETAILS OF ARCH OF YARDLEY BRIDGE

The drainage of the bridge is taken care of by means of an 8-in. cast-iron pipe, extending from the valleys over the piers to the soffit of the arch (Fig. 2). It was at one time intended to place track tanks just west of the bridge, but experience showed that track tanks which were in service near the approaches to the old bridge resulted in an excess of water splashed from the tanks onto the old bridge. At one time this splashing was so great in the winter that a dangerously heavy coating of ice formed on the old bridge members. Rather than subject the new bridge to the possible excess of water from the tanks and also from possible freezing in the fill, the railway com-

pany has decided to move the present tanks, which are located just west of the old bridge on the embankment approaches, about a mile and three-quarters west and the work of constructing them is now in progress.

Embedded in each of the spandrel walls is a 4-way vitrified clay conduit with manholes placed at frequent intervals to carry the present and future lines of telephone and telegraph wire.

The forms of the bridge were made exceptionally smooth and tight, as noted below, so that no surface finish other than that formed by spading against these forms

FIG. 3. VIEW LOOKING WEST ACROSS YARDLEY BRIDGE DURING CONSTRUCTION

was required. This has resulted in an extremely good surface texture.

LOADS AND STRESSES—The bridge was designed for the standard P. & R. Ry. loading for a 5500 lb. per lin. ft. of train preceded by two 2-8-0 locomotives and tenders, with 55,000 lb. on driver, 27,500 lb. on pilot and 44,000 on tender axles. The permissive maximum limit of compressive strength in the arch ring was 300 lb. per sq.in.

MATERIALS

The concrete used was of two classes. A 1:2:4 mixture was used in the first 4 ft. of the foundation. From this point to the springing line of the arches the mixture was 1:3:6 and the arches and spandrel walls were of 1:2:4. Embedded stones were allowed in the foundations and piers, but not in the arch rings or spandrel walls. One- to two-man-size stones were used for this purpose and procured from a local quarry for the New Jersey side of the bridge and imported stone on the Pennsylvania side. The quantity of stone used varied in different courses of the work, depending upon the convenience of the stone piles and the ability of the derricks to handle the concrete and place it in the forms as fast as it reached them from the mixer. As it was necessary to use the same derrick for both concrete and stone, the stone was placed when convenient, the concrete having the preference.

The coping was composed of a 1:3:6 mixture and the railing posts of a 1:2:4 granolithic mixture, the stones for the posts being of a ¼-in. trap rock cleaned of dust.

A standard portland cement tested by the railroad company in its laboratories at Reading, Penn., was used on all the work. The sand used in the concrete on the Pennsylvania side of the bridge was a well graded bar sand dredged from the Delaware River near Burlington, N. J. That used for the New Jersey was a bank sand from Birmingham, N. J. Freight rates governed the contractor in using the two different sands. While the

FIG. 4. VIEW OF ARCH RIB BEFORE THE HAUNCHING THICKNESS WAS ADDED
(Cableway tower passing through arch barrel)

specifications called for crushed rock to be used in all concrete, the contractor was allowed to use river pebbles for the Pennsylvania side of the structure, these being well graded in size from ¼ to 1¼ in. Crushed stone was used for the New Jersey side, ranging in size from 1¼ in. to a small percentage of dust, being the run of crusher.

The total quantity of concrete of all kinds in the bridge is 34,670 cu.yd., made up of the following materials: Cement, 42,363 bbl.; crushed stone and pebble, 37,172 tons; sand, 21,954 tons; embedded stone, 2558 tons; steel reinforcement, 262.5 tons.

The total area of surface to be waterproofed will amount to about 42,000 sq.ft. The stone spandrel filling will amount to about 7500 tons. There were used for construction purposes about 1,400,000 ft. b.m. of lumber,

800,000 ft. of which was required for the centering of the arches.

Construction

Plant—As a matter of convenience and particularly to promote the facility in procuring material, work was conducted from both sides of the river, duplicate plants being located on the New Jersey and on the Pennsylvania shores. Figs. 5-6 show at the left the plant as installed on the Pennsylvania shore up to the state line in the middle of the river, and the right the plant installed extending from the New Jersey side up to the same state line.

At the Pennsylvania half of the bridge the materials were shipped in over the Reading Ry. to a siding at the grade elevation of the main track and from there dumped through chutes over the embankment to the storage pile below (for the sand and stone) and to the warehouse (for the cement). This embankment being about 45 ft. high afforded unlimited capacity for the storage of material at practically no additional cost for rehandling. The cement house, which had a capacity of about 14 cars, had a narrow-gage track laid on the floor upon which a car containing a skip holding 50 bags could be operated to serve the mixer about 100 ft. distant. A derrick placed near-by controlled the sand and stone dumps as well as the cement from the storage house to the mixing plant, from which a narrow-gage track ran out to the bridge proper.

On the New Jersey side the mixing plant was located some seven or eight hundred feet back from the shore

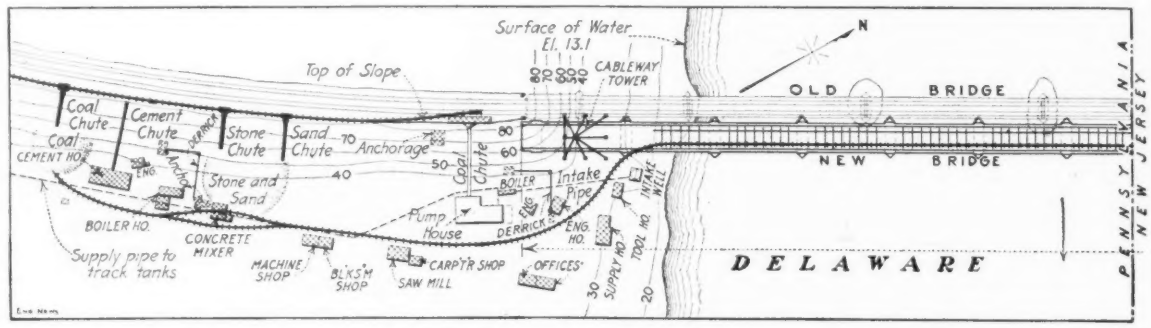


Fig. 5. Pennsylvania Side

Figs. 5-6. Plant Layout for Construction

near a siding of the Reading road, which connected with the Belvidere division of the Pennsylvania R.R. Over this line all materials for the New Jersey half of the bridge were shipped. A derrick operating a clam-shell bucket unloaded the cars and delivered concrete materials either to the mixing bins or to the storage piles.

The mixing plants on both sides of the river were of similar construction, containing a batch mixer sufficiently elevated in timber framework to dump the mixture into cars or into buckets on flat cars. Above the mixer were provided the automatic measuring and storage bins.

On the Pennsylvania side of the river construction was carried on from a temporary pile trestle, built on the center line of the new bridge, reaching to the middle of the river at Peir 7. This trestle supported a 20-ft. gage track for the operation of a steel traveling crane, which was used in placing the coffer-dam, in excavating the pier foundations and in placing the concrete from the flat cars into the foundations or forms. It also supported a narrow-gage track used in transporting concrete, etc., by small locomotives from the mixing plant. On the New Jersey side construction was handled by a series of stiff-legged derricks, placed south of the bridge and midway of the piers so that each derrick served two piers. These were used in handling the excavation and the placing of materials in the piers. A temporary trestle carrying a narrow-gage track extended into the river to a point between Piers 8 and 9, and the track from it extended back to the mixing plant.

Work on the Pennsylvania side started in the middle of the River at Pier 7, which was completed to the springing line of the arch before work was started on Pier 6, after which it was necessary to abandon the river trestle between the completed piers. This work proceeded in similar fashion toward the Pennsylvania shore. At the same time work proceeded from Pier 8 east toward the Jersey shore, working on the temporary trestles and derricks there. While this preliminary work was going on a cableway on the center line of the new bridge was

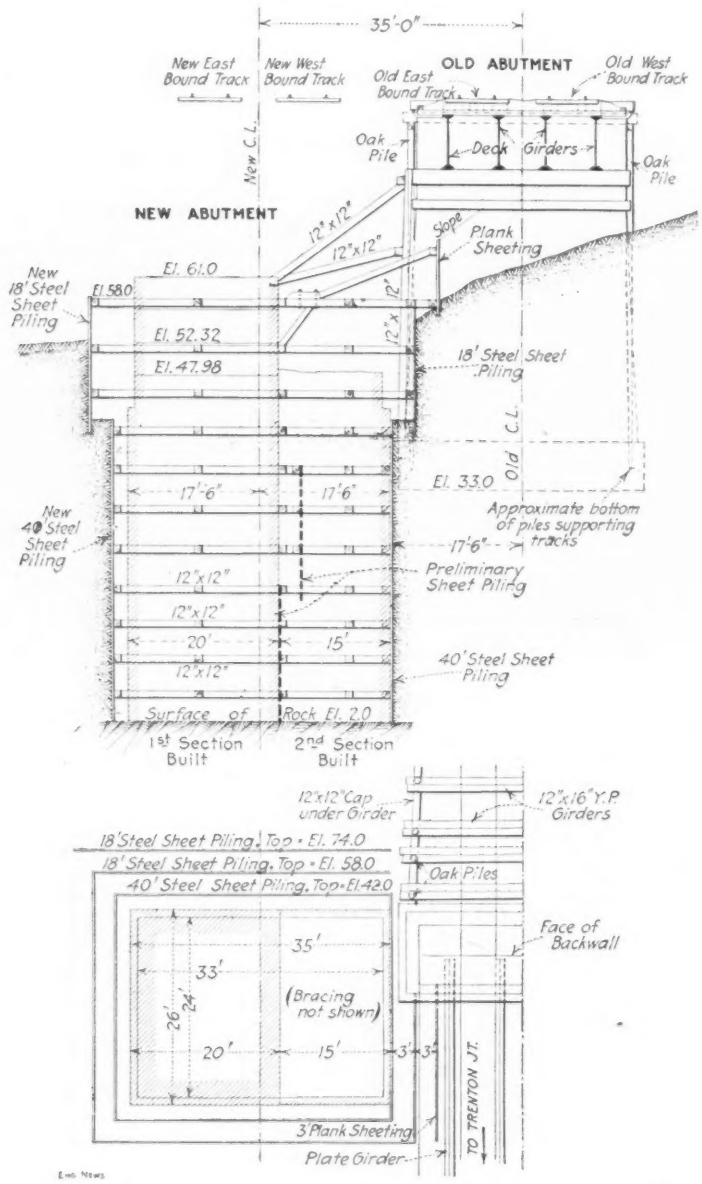


Fig. 7. Details of Method of Building the West Abutment

being installed. The Pennsylvania tower for this cableway was located between the west abutment and Pier 1; the New Jersey tower between Pier 13 and the east abutment. It had a clear span of 1320 ft. between towers 125 ft. high. These towers were of long-leaf yellow pine, supported on concrete foundations. They were composed of eight 12x12-in. posts to a height of 78 ft. and four posts for the remainder of the distance to the top, all posts being braced by 3x12-in. sticks. A saddle at the top of three 12x14-in.x6-ft. oak timbers supported the cable. A total of about 28,000 b.m. of lumber was used in each of these towers. The main cable was 1¾ in. in diameter, made up of six strands of 19 wires each of plow steel with an ultimate stress of 112 tons. The cable was supported on an A-frame at the center pier, dividing it into two spans, each of which was operated by an engine at the respective ends of the cableway. The installation was made by the S. Flory Mfg. Co., of Bangor, Penn. This cableway was used for the remainder of the concrete work above the springing line of the arches and in placing the forms and centering.

In building the spandrel walls a movable sawmill installed by the contractor proved of great economy in resawing the heavy lumber required in the heavy part of the work into the smaller sizes for use in the pilasters and railings.

FOUNDATIONS—All of the piers were founded on bed rock, being placed in coffer-dams built of steel sheet piling driven with a steam hammer through a maximum of 6 ft. water (summer stage) and 8 ft. of heavy gravel, sand and boulders to the bedrock. Most of the unwatering of the coffer-dams was done with two 6-in. pumps. Some difficulty was experienced at first in lowering the water, but this was checked by placing burlap bags filled with earth against the outside of the piling. Long wire rods were used to puddle the gravel and silt along the outside of the joints. This assisted very materially in closing up any leaks through them. The excavated material was placed on the outside of the dams, which also aided in reducing the leakage. Although the piles in many instances penetrated the top stratum of the shale rock some 12 or 18 in., a great deal of water came into the dams at the bottom of the piling and interfered in the placing of the foundation concrete. The dams were about 24 in. wider than the neat foundation lines of the piers and this space was taken advantage of in leading the water around the outside of the concrete to the pumps at the end of the dam.

Enough of the steel piling, which was 12 in.-sections 18 ft. long, was purchased to cover five dams, or about 11,500 lin.ft. The first driving of five coffer-dams required 11,160 lin.ft.; the second driving of five dams required 10,980 lin.ft., and the third driving, 11,460 lin. ft., a total of 33,600 lin.ft. It will be seen that most of the piling was used three times. With the exception of a section of the dam at Pier 13, which was allowed to remain to protect the bank of the trestle water power canal, all the 18-ft. lengths of piling were recovered. The loss to the contractor by reason of the steel splitting open, or bending, or otherwise becoming damaged so as to be worthless for further use did not exceed 5% of the total, so that of the 637 pieces brought on the work, 600 were recovered and available for use on other work.

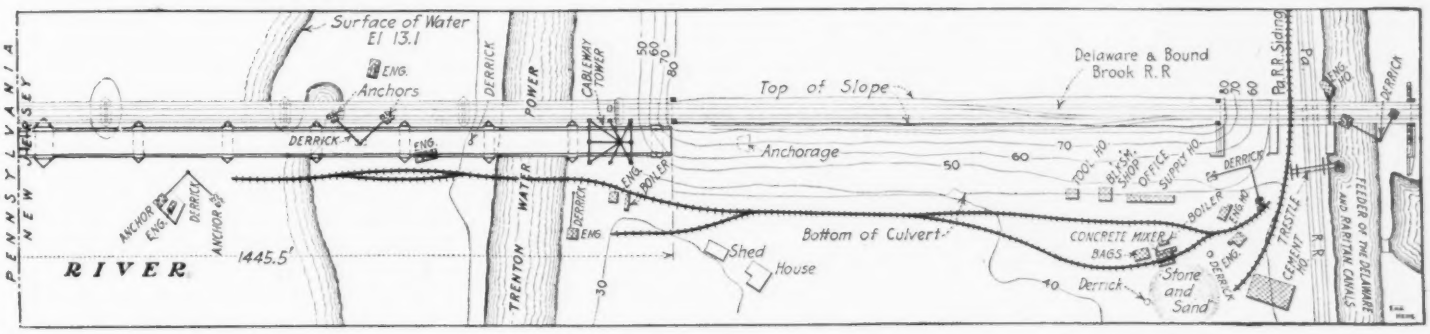


FIG. 6. NEW JERSEY SIDE OF P. & R. R.R. BRIDGE, YARDLEY, PENN.

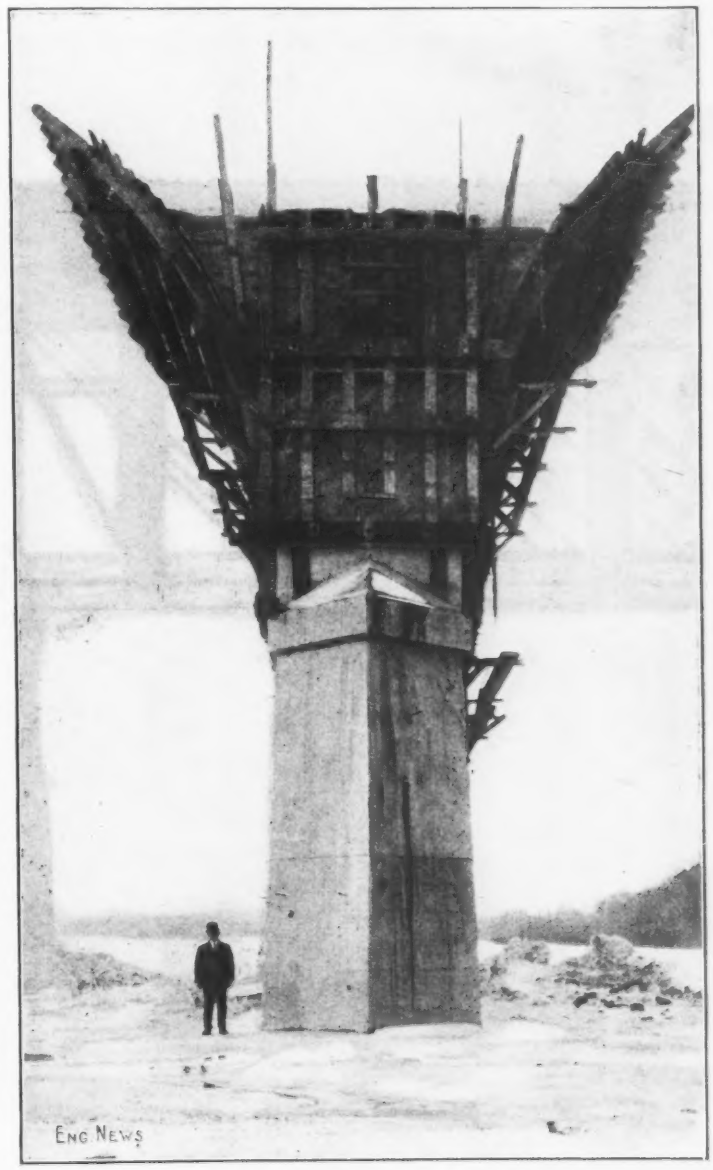


FIG. 8. VIEW OF ONE OF THE PIERS AND THE SO CALLED UMBRELLA

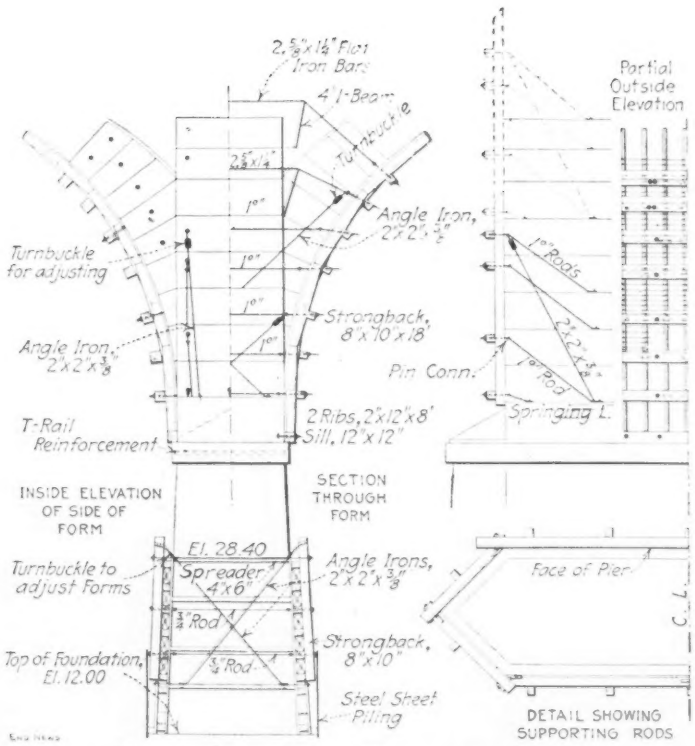


FIG. 9. DETAILS OF FORMS FOR PIERS

The abutments were originally designed to be built on concrete piles driven to rock. This construction was adopted on account of the proximity of the new abutments to those of the old, and the fact that the west abutment was founded about 30 ft. above the rock and the east abutment about 20 ft. The west abutment was first attempted. Here about 35 of the Chenoweth pattern piles were driven to the gravel, and in each case it was impossible to penetrate further. The piles were badly broken at the ends and several were broken and sheared off below the surface, so that it was deemed unwise to proceed with this construction, and arrangements were made to excavate to rock.

The method of building the abutment is shown in Fig. 7. Excavation to bedrock between steel sheet piles was first made for the southern half of the new abutment, which half was about 15 ft. south of the south face of the old abutment. This precaution was taken because the new abutment was so far below the old as to endanger the stability of the latter, if excavation were made close up to it. In order further to preserve the stability of the existing abutment carrying the main line railway, trestle bents were driven under the track just beyond the abutment (see Fig. 7).

The south half of the new abutment was carried to Elev. 61 (well above the springing line of the arch) and the old abutment then braced across to the new concrete, while the intervening half of the new abutment was built.

At the east abutment the excavation was carried down to the top of the 40-ft. sheet piling, shown in Fig. 7, without the use of a crib, the bank being sloped. The excavation was then carried to rock without the partition bulkhead.

There was a slight settlement of about 4 in. noted in one end of the old abutment, but nothing more serious resulted. A great deal of water was encountered in the excavation and much of it had to be raised about 42 ft. One 10-in. and one 6-in. centrifugal pump were used in unwatering the excavation.

METHOD OF LAYING UP ARCHES—As noted previously in this article, the piers were completed up to the springing line of the arches successively from the center toward each side of the river before any work was started on the arch ribs proper. These piers were carried up uniformly to the beginning of the arch curve in rectangular box form. Above that point the portions of the arches which were self-supported were erected as a balanced load, extending out on either side of the pier in the form shown in Fig. 8. This portion of the pier was known as the "umbrella."

When the piers were completed, arch centering was

FIG. 10. VIEW OF TWO ARCHES UNDER CONSTRUCTION, SHOWING CENTERING

erected for the four arches nearest the center arch on the Pennsylvania side of the river, that is, Arches 4, 5, 6 and 7, and concreting proceeded from the center pier toward the Pennsylvania side in such fashion as to place a balanced loading on each of the centers successively. Fig. 12 and the accompanying table will show the method of laying up these arches, it being understood that new centering was provided for each successive arch with the exceptions noted below under "Forms and Centering." It will be noted from the drawing of the arch in Fig. 12 that the arch ribs were divided into five sections, each section extending for the whole width of the arch rib, and having a balancing section on the opposite side of the crown of the arch. They are section *A* near the crown, section *B* at the haunch, section *C* near the springing, section *K* the key at the crown, and section *H*, the

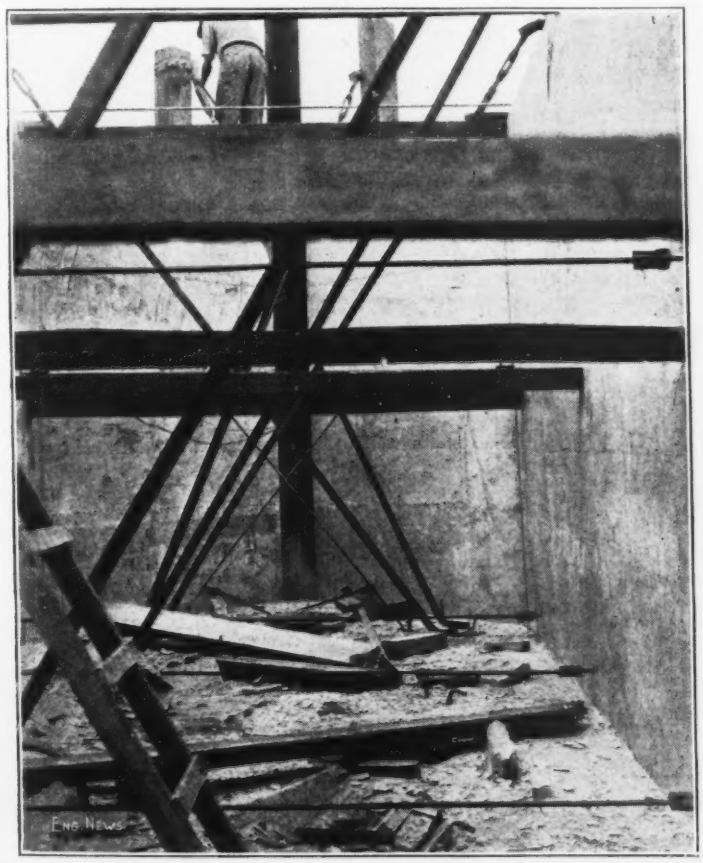
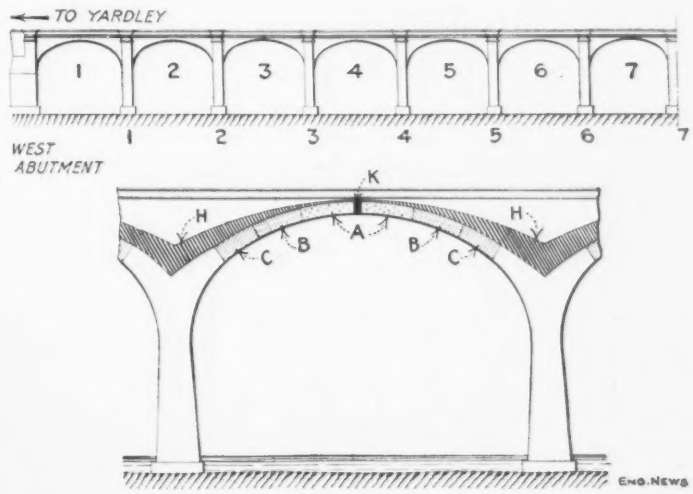


FIG. 11. INSIDE OF ONE OF PIER FORMS

final so called "haunching" addition, which brought the showing-depth thickness of the arch rib up to the full thickness. No centers were struck until at least three of the adjacent arches had been keyed.

The sections were laid up from the center of the bridge toward the end, so that no two sections on the same side of one arch would be laid on the same or successive days, and so that the progress of section laying on each dam would follow the order *A, B, C, K, H*. The order of laying is best understood from the accompanying tabular representation in Fig. 12. The "haunching" section *H* was not placed until the key section had received a hard set, and the centering was required to be maintained under a completed arch ring for at least 30 days. Two opposite sections amounted in contents to about a ten hours' run of the mixing plant. The joints of the sections, it will be noted, correspond with the expansion joint of the arches, as shown in Fig. 2. In order to prevent the bonding of one section with the other, and to form a cushion between them, corrugated asbestos boards were placed on the sides of each joint.

FORMS AND CENTERS—Especial care was taken to produce strong and economical forms. Those for the piers (as well as for all the rest of the bridge) were made of uniform standard sizes so that they could be used over



Date	No. of Block	Location on arch No. 7	6	5	4	3	2	1
6/15	1	A_7	..	..	..	..	..	..
18	2	..	A_6	..	..	..	..	..
20	3	C_7	..	..	..	..	..	..
25	4	..	..	A_5	..	..	..	..
25	5	..	C_6	..	..	..	..	..
26	6	B_7	..	..	..	..	..	..
28	7	K_7	..	..	..	..	..	..
7/17	8	..	..	..	A_4	..	..	..
18	9	..	..	C_5	..	..	..	..
19	10	..	B_6	..	..	..	..	..
19	11	H_7	..	..	..	..	..	..
20	12	..	K_6	..	..	..	..	..
20	13	H_7	..	..	..	..	..	..
29	14	..	..	..	..	A_3	..	..
30	15	..	..	..	C_4	..	..	..
31	16	..	..	B_5	..	..	..	..
31	17	..	H_6	..	..	..	..	..
8/1	18	..	..	K_5	..	..	..	..
8	19	..	..	..	..	..	A_2	..
10	20	..	..	..	..	C_3	..	..
12	21	..	..	..	B_4	..	..	..
12	22	..	..	..	K_4	..	..	..
15	23	..	..	H_5	..	..	..	..
16	24	..	..	..	..	..	..	A_1
17	25	..	..	..	..	..	C_2	..
19	26	..	..	..	..	B_3	..	..
19	27	..	..	..	..	K_3	..	..
20	28	..	..	..	H_4	..	..	..
21	29	..	..	..	..	..	..	C_1
22	30	..	..	..	..	..	B_2	..
22	31	..	..	..	..	..	K_2	..
23	32	..	..	..	..	H_3	..	..
24	33	..	..	..	..	..	..	B_1
27	34	..	..	..	..	..	H_2	..
27	35	..	..	..	..	..	..	K_1
30	36	..	..	..	..	..	..	H_1

FIG. 12. PROGRESS OF LAYING CONCRETE IN ARCHES

and over again on the various piers. The section on the pier proper comprised two parts, one for the lower plinth and one for the umbrella form. Fig. 9 shows the details of these forms and Fig. 8 is a view of the umbrella forms in position.

The forms for the piers were made up in sections measuring about 12x16 ft. They were composed of 8x10-in. horizontal timbers, spaced about 2 ft. c. to c. as shown in the drawing, and provided with two thicknesses of 1x8-in. boards placed diagonally for the lagging. Upon the face of this lagging was tacked sheets of No. 22 galvanized sheet iron against which the concrete was spaded, as noted before. These forms were assembled on the shore, provided with special lifting rods so that they could be carried into the position with the derricks. They were held in position with ¾-in. rods and 4x6-in. timber spreaders across the pier. Attached to the ends of the rods were wrought-iron swivels,

receiving the square nuts of stub bolts which passed through the forms to outside vertical waling pieces. The stub bolts extended several inches into the concrete and were removed to release the form, leaving the bolt holes in the concrete to be closed with mortar. The forms were adjusted to line at the top by turnbuckles attached to 2x2x⅜-in. angle-iron cross-braces, which were anchored into the lower section of the concrete previously placed. After the concrete was placed in the section of forms as described above, the forms were removed, lifted up and attached to the angle iron as noted.

The umbrella forms were built in the same way after the same general design, altered to suit the peculiar shape. Details are shown in Fig. 9. In this drawing the method of attaching the cross-bracing iron bars to the anchor angle iron should be noted. Fig. 11 shows the interior of one of the pier forms before the placing of the concrete. The smoothness of the surface which is provided by the galvanized steel is particularly noticeable. All these forms were used over and over again with a very small percentage of failure and with a very large degree of economy. The upper parts of the pilasters, the spandrel walls and the arched-rib forms were all built after the same style as the ones noted above with the alterations to fit the particular cases.

The main centers, shown in Fig. 10, were made up of seven ribs, having a clear span of about 70 ft., supported at the ends on inclined timber bents resting on the coping of the piers, and suspended from the umbrella section by means of seven 1½-in. rods passing through the concrete to the back of the arch. The coping of the piers was reinforced with T-rails to take the thrust of the loaded centers, and in the middle the centers were supported by timber towers measuring 21x33 ft. at the base and founded upon 14 timber piles. Four sets of oak wedges were used under each rib, which were built in half sections for ease in erection. The centers for Arches 1 to 11 inclusive were all built new for the respective arches. In Arch 12, the ribs were all new except one, which was rebuilt from a 90-ft. 9-in. rib. In Arch 13, four ribs were new and three rebuilt, and in Arch 14 all seven ribs were rebuilt from other centers. All the forms and arch centers were of short-leaf yellow pine and were designed by the contractor.

In framing the centers they were given an additional height at the crown of about 1¾ in. above the plan height to allow for any compression in the centers and in anticipation of some settlement after they were struck. Levels were taken on the centers before and after completing the crown section (section *A*), on completion of the key (section *K*), and before and after striking the centers. The greatest deflection was at the time of completing the crown sections which ran from 0.05 to 0.13 ft. In the first centers that were built an attempt was made to obtain the additional height at the crown by manipulating the wedges, but this proved unsatisfactory. The remaining centers were then framed so as to give the required 1¾ in. additional height at the crown. Most of the arches deflected so as to be about ¼ in. below the plan elevation at crown at the striking centers, and four of the arches were ¼ in. higher.

Personnel

The construction work on the bridge was carried on under the direction of the Philadelphia & Reading Ry., of which William Hunter is chief engineer, the work being in direct charge of Edwin Chamberlain, assistant engineer, with H. L. Laning, assistant engineer on the ground. The contractor for the entire work was the Talbot Construction Co., of New York City, and their superintendent on the job was John E. Jones. Work was started on May 15, 1911, toward assembling the plant. On July 21, 1911, the first concrete was deposited. The bridge is now nearly completed, and is expected with the approaches to be ready for laying of rails about July 1. No date has yet been fixed for the opening to travel.

Reclamation of Swamp Lands in North Carolina*

By Joseph Hyde Pratt†

In North Carolina the problem of reclamation of the swamp lands has been worked out more systematically than in any of the other South Atlantic states. There are approximately 4505 sq.mi. (in the eastern part of the state), a large proportion of which is susceptible to reclamation. Some of the swamp areas do not contain land well adapted to agricultural purposes, but vast areas would be capable of growing a variety of products, and these would not be far from railway transportation.

There are three distinct classes of swamp areas. The first is the great gum and cypress swamp which occurs in a long narrow belt ranging from ¼-mile to two miles in width, or in an extensive area several miles in diameter. Originally, these swamps were heavily timbered, but most of the timber has been removed or is under contract to be removed. This class of swamp land is especially adapted for agricultural purposes, when the excess water is removed, but it has little value for reforesting. The second class is open marsh, with very little timber and that of poor quality. The drainage has to be deeper and the soil is not as easily brought into a good state of cultivation as that of the first class. The third class is the higher land along the swamp areas, which it is now possible to cultivate, but which is constantly being drowned out by excessively rainy weather.

Long before the Civil War attempts were made to drain certain of the smaller swamp areas, but most of these were only partially successful, and attempts to drain on a large scale were failures. Three obstacles formerly stood in the way of the drainage of the swamp lands: 1, cost of clearing the land; 2, the cost of digging adequate canals and ditches; 3, lack of adequate laws that would permit the carrying out of the drainage proposition. All these obstacles have been removed, and it is possible to drain successfully any land that has sufficient agricultural value. The Drainage Act passed in 1909 and amended in 1911 makes it possible to carry out any drainage proposition, no matter how large or how many counties it may include. There are now 40 districts organized or in process of organization in eastern North Carolina.

After the main canals and laterals have been dug, the land is cleared by cutting the trees and underbrush; it is then burned over, leaving nothing but the large stumps. The stumps rot very quickly in this rich soil, so that no effort is made to remove them, except as they decay. The first year after the canals have been made, and land cleared, the land is planted with corn by means of a hand drill. There is no opportunity of plowing, so that the corn is planted by simply running the drill into the ground and dropping the seed. It is impossible to cultivate the crop while it is growing on account of the stumps. The fires, however, have destroyed all of the undergrowth and weeds, so that there is nothing to interfere with the growth of the corn. Land planted in this way has produced an average of 40 to 50 bushels of corn to the acre.

Another result of the drainage of the swamp lands is a general betterment of the health conditions of the section, and also the provision of good roads. In digging the drainage canals, if a little care is exercised and with but little increase in the cost, a good road can be made on the banks of the canals, from the earth thrown up.

*Abstract of an address made at the National Drainage Congress at St. Louis Mo., April 10-12.

†State Geologist, Chapel Hill, N. C.

A Borough Surveyor and Master of Works for $389 a Year!

The "Royal Burgh" of Kirkcudbright, Scotland, recently advertised for a Surveyor and Master of Works, to devote his whole time to his position, and to be paid £80 or $389 a year. In accordance with British and Scotch practice, applicants for the position were sought by public advertisement. They were directed to file their applications with the town clerk by Apr. 5, 1913, together with copies of testimonials.

It might be thought that a place of only 2191 population (census of 1911), offering a salary of less than $400 a year, would not demand very much from its surveyor and master of works. On the contrary, much is demanded, as may be seen from the following "regulations," which we reprint from the London *Surveyor* for Apr. 4, 1913:

REGULATIONS FOR THE DUTIES OF THE SURVEYOR AND MASTER OF WORKS FOR THE BURGH OF KIRKCUDBRIGHT

The surveyor and master of works will be paid, to begin with, a salary of £80 a year, and for this salary he must devote the whole of his time to the duties of his office. The engagement will be for one year, and thereafter at one month's notice on either side, and his duties will be as follows, viz:

Slaughter-House Department

To visit the house every day that cattle are being killed, examine the carcasses, and see that any diseased meat is destroyed, and report such cases immediately to the veterinary inspector.

To collect the dues for the animals killed in the slaughter house, give the butchers receipts therefor, account for the dues to the chamberlain each week, and get the counterfoils of the receipts issued to the butchers initialed by the chamberlain.

Generally to see that the house is kept clean and in good order and repair, and that the regulations and by-laws are duly observed and enforced. To report to the town council every contravention of the regulations and by-laws without delay.

Water Department

To see that the water-works are kept in good order, and report any defects to the convener of the committee.

To report to the convener of the committee from time to time the quantity of water in store, the conditions of the reservoirs, springs and filter beds, and their tributaries.

To prepare estimates of cost of extensions and alterations of water mains.

To superintend all extensions, alterations and repairs of mains and hydrants.

To regularly inspect all pipes, taps and cisterns in houses once each quarter, and to enforce compliance with the regulations as to the supply of water to houses, etc.

To regularly scour the water mains, and thoroughly clean out all tanks and catchpits in October and February in each year, and to intimate to the convener of the Water Committee when this work is to be done.

To go around once every week all outside closets and see that they are kept clean and in good order, and report to the proprietor of the premises and the convener of the Public Health Committee when any of the closets require attention.

Sewerage Department

To prepare plans, specifications and estimates of the cost of extensions or alterations of main sewers.

To superintend all extensions, repairs or improvements of the sewerage system.

To see that alterations and connections with private drains are properly made and tested, and that all junctions are formed with fireclay collars.

To see that all private drains, soil pipes and sanitary appliances are kept in good order and repair, and intimate all defects to the respective proprietors or their factors and to the convener of the committee.

To carry out any special instructions which may be given him by the council or the convener of the Public Health Committee.

Roads Department

To call every morning before 9 o'clock on the convener of the Streets Committee for any instructions he may have to give, and attend promptly to these instructions.

To superintend the repair, cleansing and watering of streets and roads, and see that all the conduits for carrying the roof water below the foot pavements are kept clean.

To calculate the quantity of road metal required for the season, and measure the same when broken in heaps.

To prepare plans, specifications and estimates of cost of any proposed improvements.

To measure contract work, and give certificates for sums due to contractors.

To grant orders for opening the streets when required for connecting water, sewer or gas pipes, and see that the openings are properly filled up to the satisfaction of the committee.

To see that the burgh workmen and scavengers begin their work timeously in the morning, and go round and see that the work is properly performed.

Buildings (New and Old)

To examine plans of proposed new buildings, and alterations of existing buildings, and see that the statutory provisions are complied with; to inspect buildings during construction, and report to the council any case of contravention of the statutory regulations or of the warrant granted.

Generally

To see that all lands, houses, fences and grounds belonging to the burgh are kept in good order, the grass at St. Mary's Park and Moat Brae is properly and regularly cut, and the fences and seats kept in repair.

To prepare plans, specifications and estimates of cost of any new works, and superintend their execution, whether by contract or by day labor.

To check all accounts incurred in the various departments, and submit same to the Finance Committee; and generally to carry out the instructions of the various committees or conveners given either orally or in writing.

To have full control as to the engagement or dismissal of occasional workmen when employed at work ordered by the council or the convener of a committee, and to pay the wages of such workmen.

To report at once to the council or the Streets Committee any insubordination or disobedience to orders on the part of any of the workmen or scavengers.

To act as inspector under the Shops Act, 1911.

To carry out all the duties of a burgh surveyor, whether herein mentioned or not.

To undertake any other duties if required by the town council at such remuneration as may be determined.

To attend monthly meetings of Council and Finance Committee, and special meetings when required, and to give in a written report of the work that has been going on.

To report at once to the council when he becomes aware of any repairs being required on any of the burgh property.

To keep a daily register setting forth each day what he has been doing, and submit the register to each monthly meeting of council, or to any committee that may ask for production of it.

We call particular attention to the fact that the surveyor must see that the employees of the roads department "begin their work *timeously*"; that he must perform "all the duties of a burgh surveyor *whether herein mentioned or not*; and (a gleam of hope) that he may be called on to perform other duties, but "at such remuneration" as the Town Council may determine.

It is interesting to note that ("The Municipal Year Book") Kirkcudbright has been a royal burgh since 1455; owns three farms and some salmon fishings in the Dee; was one of the first Scottish burghs to introduce a gravity water-supply, and besides water-works also "owns the harbor, the gas-works and a cemetery."

In view of the multifarious duties and small salary of the surveyor it would seem quite proper to allow him a day off now and then to disport himself in the salmon fisheries and, as an inducement to continue in the municipal service all his life, free burial in the burgh cemetery.

Snow Surveys for Predicting Stream Flows

By J. Cecil Alter*

SYNOPSIS—The summer flow of Utah streams used for irrigation has been predicted for two seasons by measuring the actual snow depths and finding their water depth equivalents. The work has been carried on by the U. S. Weather Bureau and bids fair to be extended over wide areas for the use of all classes of water users dependent upon the runoff from snow-clad mountainous areas. The apparatus includes a measuring tube and spring balance scales, besides which use is made of a barometer for elevations and a thermometer for temperatures. The article describes the instruments and surveys, and tells of the practical use to which farmers and others may put the data.

The Snow Surveyor

The success of the mountain-snow survey scheme inaugurated two seasons ago in Utah by the U. S. Weather Bureau for the purpose of determining early in March the probable summer flow of irrigation streams has been fully demonstrated.

The plan was to go into the headwater regions of streams whose water is fully appropriated, toward the close of the snow-storing season, yet prior to the beginning of actual farming operations, and determine by hundreds of systematic depth, density and water-equivalent measurements of the snow, the amount of water stored which would subsequently flow to the service of the valley irrigators.

This being determined, a precipitation record at a representative place would show the amount of water added to the watershed after the completion of the survey; and a daily stream flow measurement at a flume, constructed above the highest water-using farm, would show the daily depletion of the supply indicated by the survey.

It was not intended to ascertain the actual acre-feet of snow-water stored on the watershed, and then charge and credit these values with the rain and snow added, and with the flow down the stream daily. On many smaller drainage systems this definite plan would be quite feasible, although in such a case an evaporation factor would need to be considered. As a matter of fact, in some erosion experiments being conducted by the U. S. Forest Service in coöperation with the U. S. Weather Bureau in the Mountains near Ephraim, Utah, this sort of survey was completed early in April, 1913, and will be repeated each season hereafter.

Instead of this precise plan, since the watershed chosen by the Weather Bureau for its original work was a medium-sized region, and perhaps typical of most of the Utah irrigation streams, the plan was to ascertain the average depth of the undrifted, lying-where-it-fell snow (Figs. 1 and 2) and its actual water contents, so that these values could be compared from year to year; and in this case stream-flow predictions would be stated in percentages of the flow in previous years instead of in actual acre-feet. The record of average weather conditions over the watershed, with the average stream gagings, would be additional factors for consideration in making the flow forecast.

And so, when the Weather Bureau snow surveyors completed the March, 1913, snow measurements, having made about 280 depth and density measurements in about 2500 acres of evenly laid snow on the upper reaches of Maple Creek, in the Wasatch Mts., near Springville, Utah, the confident assurance was issued in a printed report, and mailed to all users of Maple water, that "there is about 16% more irrigation water stored in these hills than at the same time last year." It was also found that the compactness, or density, of the snow was practically the same as it was last year, and that the ground beneath the snow contained no frost, as was the condition last year; so that if weather conditions from the completion of the survey to the close of the irrigation season average about the same as in 1912, "Maple Creek should supply about one-eighth more water this season than it did last year." And from a cursory examination of adjacent watersheds, the surveyors said it was quite probable that conditions in the Maple watershed were an index to conditions in near-by mountains.

The water prospects from this stream will remain one-eighth better than last year only as long as weather conditions subsequent to the measurement of snow remain similar. However, the effect of cooler, warmer, wetter, or drier weather will be more or less directly reflected in the stream gagings, so that from the weir measurements from week to week, compared with the flow measurements of corresponding dates last year, the water probabilities can at any time in the season be recomputed for the benefit of those farmers who may wish to know whether to divide the water freely between the alfalfa and the potatoes, or to give sparingly to the crop in greatest need.

In fact, there are a great many uses the farmer can make of this information. For instance, he may have insufficient water to mature his third crop of alfalfa, and rather than let the third crop go to pasture which he may not need, or plow it up for fall wheat, which he may not wish to do for many good reasons, he can probably turn the water shortage into an actual profit by letting the second hay crop go to seed.

He could not snatch such a success from imminent failure except by chance without an accurate, definitely stated knowledge of the amount of water available. Variations of the case are numerous, even complicated frequently, especially where the water has been so completely appropriated and utilized that only primary water-rights owners may expect plenty, the secondary rights, probably representing a majority of the acreage, suffering frequently through lack of water.

If these secondary users knew definitely, early in the spring (as the three hundred users of Maple water know this spring) that they may expect 16% more water than

*Observer, U. S. Weather Bureau, Salt Lake City, Utah.

they had last year, they could lay their entire summer plans with that important fact in view. They might not only secure outside range pasture, letting the alfalfa grow into three crops, and also increase the potato and beet acreage, but they might even include an additional strip of land under the water which seldom or never is operated as an irrigated tract, through scarcity of water.

The making of the survey consists in going up the bottoms of the cañon branches and back and forth along the sides or slopes of each gulley or drainway, making depth soundings every few rods with an alpenstock to keep in perfect touch with the varying depth of the snow, and every few hundred feet making an accurate depth and density measurement with specially made apparatus. (The accompanying halftones show the character of the country surveyed, the instruments employed, and how they are used.)

This apparatus consists of a sampling tube, made of galvanized iron, reinforced at the ends, with a light iron collar at the top, and a toothed cutting sleeve at the bottom. The tube is inserted perpendicular to the surface of the snow. It is about 3 in. in diameter and 50 in. long. With its contents, it is weighed on a spring balance scale, which is graduated to show the water equivalent, in inches deep, of the tube contents. Thus the scale reading is entered directly against the depth of snow value, which is read from the inch markings on the outside of the tube.

This apparatus was perfected by Prof. Chas. F. Marvin, in charge of the instrument division of the U. S. Weather Bureau, and so far it has met practically every demand made upon it. Naturally, the spring balance must have a rigid support, but this is provided by thrusting the alpenstock—the sounding staff—into the snow at an angle. The newer spring balances are made of aluminum and are thus easily carried.

A typical observation follows: Snow depth, 39.5 in.; water equivalent, 12.7 in.; barometer, 22.12 in.; thermometer, 19°.

Surprising as it may seem, the drawing up of the snow core, or sample, is a very easy matter in practically all cases, the only difficulty ever experienced being in very warm weather, while working in wet, slushy snow; but even under these circumstances the cutting sleeve, or a wad of earth gathered with the snow, offers sufficient obstruction to enable one to secure the snow sample by deft manipulation.

The opposite condition, of the snow freezing to the inner sides of the tube when air temperatures are below 20°, is a more formidable problem; yet even this difficulty was very readily overcome in temperatures as low as 10° or 15° by cleaning the tube with an oiled rag on the end of the alpenstock.

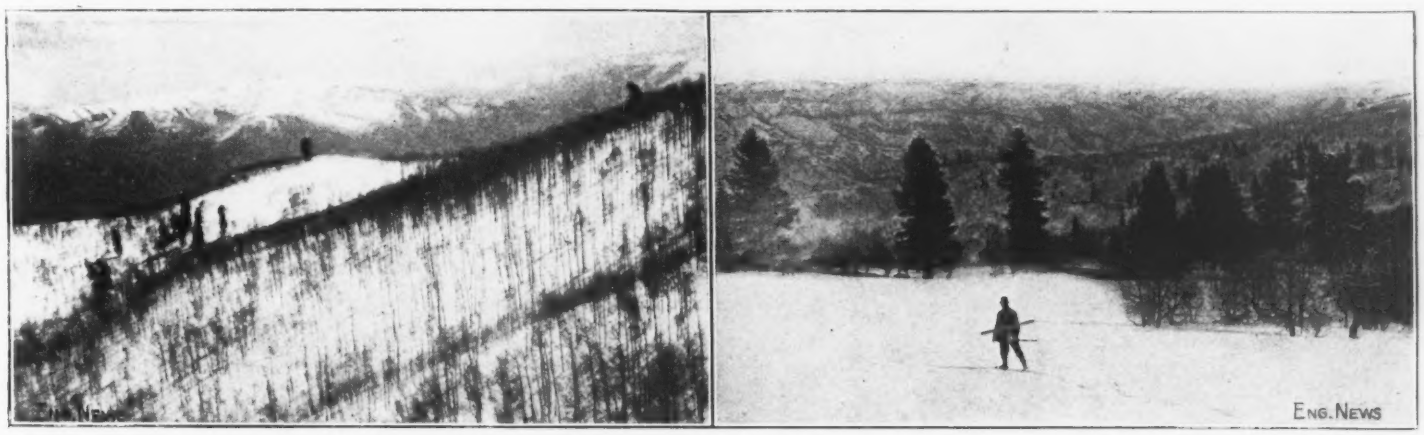
Where the snow depth was more than the capacity of the spring balances the sample was taken in two or more sections; where the depth was beyond the length of the tube the surface snow was dug away from one side of the tube and the complete sample then taken. Snow 7 ft. deep has been successfully sampled with a 50-in. tube with very little loss of time. As a rule this process is greatly preferred to carrying a longer, heavier snow tube over the mountains.

A thermometer reading was made at every sample-taking, together with a reading of an aneroid barometer and the time reading from a watch. These readings, in connection with continuous temperature and barometer readings at the base of the mountains, make it possible to calculate the altitude of every observation point.

An examination of the soil beneath the snow was made at every snow measurement to determine the amount of frost in the ground, because a continuous, well formed frost layer has a very important effect on the amount of water conserved naturally during the first thaws of spring; that is, during the spring runoff. Strangely enough, however, the ground in the mountains is almost never frozen beneath the snow. Where unfrozen, this information is readily gained by means of the snow sampling tube, as dirt samples are quite as easily secured as snow samples. Where there actually is a frost layer its thickness is ascertained by means of a small prospector's pick and a short driving bar.

Phenological observations were also made of the growth stages of the willow, quaking aspen and bush buds, as these are indications of the advance of the springtime, and the information is useful for comparison with other years, and for consideration by the farmers themselves.

During the work at Maple Creek this year soil temperatures beneath the snow were taken accurately, the value being 33° everywhere in the soft moist earth within 10 in. of the snow. The perpetual springs which burst forth through the snow at intervals along the cañons, showed temperatures of from 43° to 44° near the upper limit of all-winter flowing, and 48° near the valley at the outlet of the creek, varying apparently with the depth be-



FIGS. 1 AND 2. EVENLY COVERED SNOW-GATHERING GROUNDS IN UTAH

(In the foreground of Fig. 1, on the left, is a part of the watershed of Maple Creek; in the background are the Wahsatch Mts. Fig. 2, on the right, shows a heavy March layer of snow. Note the even distribution of the snow in the views. Under conditions shown here and in Fig. 3 snow measurements are comparable from year to year.)

FIG. 3. TRUDGING ALONG A GENTLE SNOW-COVERED SLOPE

FIG. 4. CLIMBING A 45° SLOPE ON SNOWSHOES

FIG. 5. THE HARDEST WORK OF THE SURVEY

FIG. 6. SNOW-SURVEY APPARATUS

FIG. 7. SECURING SOIL SAMPLE IN SEARCH OF FROST

FIG. 8. A MEASUREMENT BEYOND DEPTH OF TUBE

FIGS. 3-8. MAKING A SNOW SURVEY IN UTAH

(The surveyor goes on snowshoes, provided with an alpenstock, a measuring tube graduated in inches, a spring balance graduated to show equivalent water depth in inches, a thermometer and an aneroid barometer. A density or water-depth determination is being made in Fig. 6. In Fig. 8 the snow was so deep that it had to be brushed to one side.)

neath the main mountain range that the water reaches before coming out again.

The snow on the Maple Creek watershed is about 5½ in. deeper than it was last year and shows little drifting except in the rougher portions of the watershed; and up to the close of the measurement period there had been only a few small snowslides even in these regions, thus indicating a firm condition of the under layers at that time. The streams were all comparatively low, being closed by frost and snow over the upper half of the watershed.

Practically the entire watershed carried a snow covering of a trace or more this year. It was also discovered that a comparatively small acreage carried as little as a trace or broken covering of snow. The density measurements, or determinations of the actual water contents of the snow by weighing, showed noticeable uniformity throughout the regions examined.

Owing largely to the impracticability of securing measurements of the snow that will be comparable from year to year in the rougher portions of the watershed and on the steeper slopes no systematic measurements were made

this spring in certain limited regions. It is, therefore believed that in the figures herewith presented of the snow layer over the smoother portions of the watershed, we have records that represent very closely a measure of the amount and the condition of the snow that will form a basis for fairly accurate comparisons with measurements in other years.

The comparisons made in the accompanying table may be considered direct, as the averages and values for identical regions have been computed for this purpose. In comparing the 1912 and 1913 figures with the previous values obtained in 1911, however, it will not be overlooked that these last-named figures were obtained two weeks later in the season.

So important has the snow-survey work been proven that a half-dozen irrigation companies, towns, and farming communities, have already begun the systematic measurement of the snow on their watersheds in the early spring. Many light, power and water companies sell their products on yearly contracts, which are made during the late winter and early spring. If an operating company finds that it has 10% more water in the hills than in a previous year, it can sign up and fulfill an increased number of contracts with safety; whereas, if the survey shows a shortage it can protect itself from loss by not entering into contracts for light, power, or water that it cannot fulfill.

That the work will ultimately extend into every part of the irrigation country seems assured, from the interest already being taken in it. The U. S. Weather Bureau plans to continue the work at Maple Creek, if practicable, for some years, to gain all the experience and information necessary for guiding others in the work, though it already appears from a close study of the Maple Creek records by individual branches that certain configurations of watershed, and certain smooth regions show striking similarity with the average records for the entire watershed; that is, certain limited regions are (natural law says they must be) true averages for the entire watershed; and if the experiences at Maple Creek prove ultimately that limited regions on a watershed may be selected for examination which will fairly represent the conditions over the entire watershed, the cost would not only be greatly reduced and thus render the scheme more practicable and profitable, but the snow-measurement period would be more nearly an instantaneous observation, as in theory it really should be.

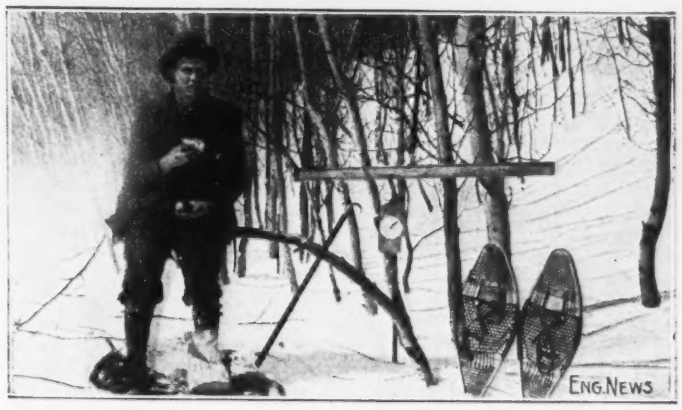


FIG. 9. STOPPING THE SNOW SURVEY 20 MINUTES FOR LUNCH

Many of the snow surveyors at work in Utah and Idaho are using the Weather Bureau apparatus and methods.

COMPARATIVE SUMMARIES OF SNOW MEASUREMENTS MADE DURING THE PAST THREE SEASONS IN THE MAPLE CREEK WATERSHED, UTAH

Date	No. of measurements	Average depth of snow	Water in snow	Per cent. of density
Entire watershed				
1911 March, last half	195	35.4	10.8	31
1912 March, first half	266	42.2	10.2	24
1913 March, first half	281	47.8	11.8	25
Summary of Typical Branch Cañon				
1911 March 26, 27	65	38.7	13.4	35
1912 March 8, 9	91	45.6	11.5	25
1913 March 10, 11, 15	85	50.8	12.7	25

The government aims to supply the apparatus wherever possible, and it is only for lack of funds for this specific purpose that the Bureau does not actually perform the work on every watershed where a stream-flow forecast would be valuable.

Alfred H. Thiessen, in charge of the Salt Lake City office of the U. S. Weather Bureau, who also has charge of the snow survey work of the Bureau in Utah, plans to coöperate with every water company in the state with the end in view that the government shall supply all instruments, and possibly send experts to show the farmers and engineers how the work is done, and to publish and distribute from Salt Lake City all information obtained in this way. This would result in surveys being made in fifty instead of a half-dozen watersheds, and from this many actual measurements made simultaneously, estimates for intervening watersheds (not measured) could be made.

It has been proven that the cost should be comparatively small, as the labor in most cases could be supplied by men in the employ of the water companies who are not doing other work at this time of year. And where most of the company are farmers, the work may be done by volunteers, as has been done for two years already at Moroni, Utah. In this way, with the instruments furnished by the government, and the computing, publishing and distributing of the information being also done promptly by the Weather Bureau, there need be no actual expense to the water users for this work. And as has already been demonstrated, a week's work in the headwaters of a well used stream, by two snow measures, may be worth many thousands of dollars to the community at the foot of the mountains.

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Simple Locomotives with Three and Four Cylinders are in use on a number of English railways, and ten large four-cylinder simple engines of the 4:6:0 type have been built recently at the Crewe shops of the London & Northwestern Ry. for high-speed passenger service. They are fitted with Schmidt superheaters. The four valves are operated by two outside sets of Walschaerts valve gear. All the cylinders drive the first driving axle. The tender is mounted on six wheels and is fitted with a water scoop to take water from track tanks. The engine was built to the designs of Mr. Cooke, Locomotive Superintendent, and its main dimensions are as follows:

Driving wheels	6 ft. 9 in.
Truck wheels	3 ft. 3 in.
Wheelbase, driving	15 ft. 3 in.
Wheelbase, total	29 ft. 0 in.
Weight on drivers	59 tons
Weight on truck	19 tons
Weight of engine	78 tons
Weight of engine and tender	147 tons
Cylinders (4)	16x26 in.
Boiler, diameter	5 ft.
Boiler pressure	175 lb.
Tubes, No. 159; diameter	1⅞ in.
Tubes, length	14 ft.
Tubes, superheater; No. 24; diameter	5¼ in.
Heating surface; tubes	1161 sq.ft.
Heating surface; superheater tubes	486 sq.ft.
Heating surface; firebox	171 sq.ft.
Heating surface; total	1818 sq.ft.
Superheating surface	414 sq.ft.
Grate area	30½ sq.ft.
Water in tender tank	3000 imp. gal.
Coal in tender	7 tons

General Instructions to Inspectors of Street Paving

The Bureau of Highways of the Borough of Manhattan, New York City, of which H. W. Durham is Chief Engineer, has recently issued a small book of instructions to inspectors of street paving which contains a number of interesting and instructive points. Many, indeed, are general and are intended as guides to be used in conjunction with and as a supplement to regular contract forms and specifications. A brief abstract of some of these instructions is as follows:

THE INTENT OF INSTRUCTIONS

The object and intent of these instructions is to secure full compliance with the contract and specifications and the performance of first-class work by the contractor in such minor details as are not specifically mentioned, but implied, by the contract and specifications.

GENERAL INSTRUCTIONS

The inspector is to report to and be under the control and direction of the Chief Engineer and his authorized assistants.

The inspector is to read carefully and make himself familiar with the contract and specifications for the particular work to which he is detailed.

The inspector is to assume that the contract and its specifications are entered into by the contractor in good faith and with a full understanding of the requirements; and that the contractor may be and must be held to a strict compliance with the specifications, unless the inspector receives instructions to the contrary from his superior officers.

The inspector will be held strictly responsible for the enforcement of the contract and specifications so far as these relate to the quality of the materials used and the manner of doing the work.

In case the contractor, or his agents or employees, shall refuse or fail to comply with the contract or specifications, or to perform the work in accordance with the instructions from the assistant engineer in charge, or in a proper manner, the inspector is to direct the contractor to suspend the particular work at fault and to report the facts immediately to the assistant engineer; and the inspector is not to permit the work to proceed in disobedience of his requirements until instructions are received from the assistant engineer.

The inspector is to make out daily reports on the forms provided for the purpose, and also to keep in the notebook provided for each contract a detailed record of each day of the work, which must contain the following:

(1) The date of assignment to the contract and date of its actual commencement and completion.

(2) Detailed force account for each working day and amount of material used.

(3) Condition of weather each day.

(4) Delays, reasons for, and the period of duration.

(5) Railroad or other subsurface work being done within the limits of the contract whether by corporations or individuals, the date of beginning of such work and the date of completion.

(6) Condition of the sidewalks within the limit of the contract at the commencement of the work.

(7) Accidents: Date of accident, names of persons concerned and witnesses of any circumstances governing the case.

(8) Quantity of new and old curbstone set and location of same.

(9) Any neglect or refusal on the part of the contractor to comply with the contract specifications.

(10) Damages to persons or property by reason of any act or omission on the part of the contractor.

(11) Oral instructions or orders received from the engineer in charge of the work; and all other matters appertaining to the contract that might be worthy of record.

It is the duty of the inspector to familiarize himself with the local conditions affecting the contract to which he is assigned, in order that the work at all stages may be so carried on as to cause the least possible inconvenience to the property owners on the street, and to the general public using the street. The street must not be unnecessarily obstructed, and the contractor must provide temporary bridging or passageways at crossovers and wherever else necessary.

All materials as they are brought on the street must be piled compactly and neatly on planks or metal boards in the roadway, or upon the sidewalk, at such points as the inspector designates. The inspector must see that all loose material and excavated matter, such as broken curbstone, old paving blocks, old asphalt and earth, are removed from the site of the work as soon after being excavated as possible. All unused or waste material of every sort must be removed from the roadway and sidewalk of any completed portion of the street at the time it is opened to traffic.

The inspector must see that city monuments and benchmarks are preserved from injury by the contractor, and in case of any displacement or disturbance of such marks must notify the assistant engineer in charge.

The inspector is to examine the material as it is brought on the work and see that it conforms to the specifications before permitting it to be used. It will be part of the inspector's duty to notify the office of the city chemist at the different stages of construction in due time to take the necessary samples of the different materials in each block. Should the inspector at any time suspect that the material used is not in accordance with the specifications, samples must be taken by him, with a record of the location, and the office of the city chemist notified immediately.

PREPARATION OF THE SUB-FOUNDATION

Where earth excavation or embankment is necessary to bring the subgrade to proper grade, the important points to be looked after are:

(a) To bring the subgrade to the true and proper grade and contour required for the pavement.

(b) To properly consolidate the subgrade, so that it will furnish a firm support for the pavement and its foundation.

CURBING

In setting curbstone the important points to be looked after are:

(a) To see that the stones are set to the true grade and position.

(b) To see that the full space for concrete under and around the stone is provided.

(c) That the concrete used around the stone is of the specified quality.

(d) That the concrete is placed and compacted so as to fill all the space under and around the stone as specified.

(e) That no foreign material, either dirt or broken bits of flagging, be permitted to become mixed with the concrete.

The tendency of the workmen is usually to consider the above details as unimportant and to slight them.

MIXING THE CONCRETE

The contractor often desires to measure the sand and stone by wheelbarrow loads. In such cases the inspector will measure the capacity of the barrows used and determine the size and number of loads required for one batch of concrete, and thereafter insist that the loading conform to this standard size. As a check, the inspector should frequently keep account of the bags of cement and the barrow loads of sand and of stone used during, say, two hours, and measure the quantity of concrete made and determine from this data the ratio of the materials used. In any case the inspector must make return for the amount of material used during the day on his daily report by giving the exact quantities as counted by him both as to bags of cement and cubic yards of sand and stone used, and the quantities must not be estimated from calculations based on the amount of concrete laid.

When a concrete mixer is used the inspector must acquaint himself with the theory and principle of operation of that particular type of mixer and be able to detect any change in the proportions or uniformity of the mixture at any time.

When the mixer is of the automatic-feed type the inspector must test it at least once during each day's work, at times unexpected by the foreman, by feeding measured quantities of cement, sand and stone in the proportion of one, three and six into the respective hoppers. If the mixer is gaged properly and feeding freely the measured quantities of materials will be exhausted simultaneously. Should some cement be retained in the cement hopper after the sand and stone are exhausted, it is sufficient indication that the mixer is either improperly gaged or that the cement feed is clogged. Whatever the trouble, it must be corrected before the mixer is allowed to continue.

When the contractor employs a concrete mixer into which the materials are not loaded in batches, the inspector is not to depend for the securing of the proper proportions on the accuracy of the machine gaging or the proportion of shovelers used. The materials must be placed in properly proportioned piles, not containing more than 10 cu.yd. in the case of sand, broken stone or gravel, and the inspector must see that the machine exhausts all materials simultaneously. Should it be impossible to obtain these results, due to improper piling of

material, the inspector must require the use of measuring boxes for proportioning the charge for the mixer.

SHEET-ASPHALT PAVEMENT

The principal care of the inspector will be to see that the asphalt is not laid at too low a temperature. The minimum temperature permitted by the specifications is 250° F. While the main or interior mass of a wagon-load may be well above that temperature, the top and outer part of the load may be, particularly in cold weather, too cold to be safely used. Some of this colder portion may be sufficiently reheated by mixing it with the hotter material if properly handled in unloading; but any material that is so cold as to be lumpy when unloaded or, more particularly, when being raked out, should be discarded. This applies to both surface and binder mixtures. The best practical guide is the manner in which the mixture behaves in raking. It should always be so hot that it will, under the rake, break up into a uniform crumbling or powdery mass. If it does not do this it is too cold whatever its temperature may be.

PREPARATION OF STREET SURFACES—Before the binder is laid, all loose material, rubbish, street dirt and other matter foreign to the concrete surface shall be removed and the concrete surface swept, with street brooms if necessary, to properly clean it.

Neither binder nor surface mixture shall be laid upon wet surfaces. Before the spreading of the surface mixture on the binder, the latter must be cleaned of all foreign matter and swept if necessary. If the binder course already laid has become covered with mud from wagons or other travel, it must be swept clean. No loose fragments of binder material must remain on the surface. Any part of the binder course that may have become broken or loosened must be taken up and new material laid in its place with the same care as the original.

LAYING BINDER COURSE—Nearly the same care in raking and equally as careful rolling should be required as for the surface course. If the binder is not thoroughly compressed and becomes cold before the surface course is laid, it is likely in future hot weather to soften and yield under heavy travel, and thus start small depressions in the pavement.

LAYING THE SURFACE COURSE—The joints against a cold edge of previously laid surface must be cut back until solid, fully compressed material of full thickness is reached, and the raw edge completely but thinly painted with liquid bitumen. No masses or fragments of cold mixture must be allowed to remain on the surface of the binder in advance of the placing of the surface course to be covered up by the latter. Such cold masses will not be compressed by the roller but will later, under a hot sun and heavy travel, yield and start depressions in the pavement. The raking requires to be properly and skillfully done. The tines of the rake must penetrate to the binder, so that the raked material will be a uniform mass from top to bottom.

ROLLING—The inspector must insist upon the roller being placed upon the freshly raked surface just as soon as the material will bear it without being squeezed out or displaced laterally. The tendency is to keep the roller off too long, thus permitting the chilling of the surface and preventing its proper compression. The inspector must not take the contractor's word as to how soon the rolling may be begun, but should have trials made until he is able to judge for himself.

The rolling of the heavy roller should be very thorough; the roller should be kept at work constantly until the surface is too cold to be impressed. In operating the roller lengthwise of the street the rolling should begin at the gutters and work toward the center of the street whenever practicable. Cross rolling and diagonal rolling must be insisted upon wherever the width of the street will permit.

Asphalt surface must not be laid when rain or snow is falling or so long as the surfaces are wet. Surface mixture raked out and caught in a shower before it is well enough rolled to exclude water must be taken up and discarded.

The inspector is to measure and record each day the area of pavement laid and the quantity (number of batches) of surface mixture used, and note any lack of uniformity in the area laid per batch.

GRANITE BLOCK PAVING

The more important things for the inspector to look after are:

(a) The quality and shape of the blocks.
(b) The sand cushion.
(c) The setting of the blocks.
(d) The ramming of the surface.
(e) The filling of the joints.

THE BLOCKS—Assuming that the general quality of the granite has been approved, the inspector will need only to observe and reject blocks made from soft or weathered or otherwise defective stone. Any material divergence of the blocks from the correct form or from the sizes specified as permissible will be readily caught by the eye as they are brought to the street, and can be thrown out.

The proper dressing of the blocks is important, and should be watched carefully. While the inspector is not expected to examine each individual block, close observation of the blocks as they are handled and laid will enable him to detect and reject those that are materially defective in shape or dressing; or excessively wide joints will call attention to them as they are set.

SAND CUSHION—Screened sand must be used for the cushion bed. It should be moderately coarse and must be fairly clean and pure. The tendency with contractors is to use any dirty sand or sandy loam available on the street. Such material, especially if it becomes filled with water, will yield under the blocks and will not support them properly. The sand bed should not vary materially in thickness. It should be laid and graded not more than 50 nor less than 20 ft. in advance of the setting of the blocks.

SETTING THE BLOCKS—The blocks of uniform width and depth must be selected for each course, and each block must be laid upon a full bed of sand and "struck in" at the base so as to bring the stone in close contact with its neighbor in the preceding course and thus insure the closest possible joint.

The inspector must see that the joints in the line of traffic are close, and must see that the alignment of the courses is true. This is most important, as a crooked or wavy course lessens the chances of getting close joints, not only along that particular course, but also along the courses that are to follow. The inspector must see that all longitudinal joints are broken by a lap of at least 3 in.

The operation of ramming is not to be permitted to approach within 20 ft. of the paving. After ramming the surface of the pavement may look somewhat wavy and uneven. The inspector must see then that it is back-rammed. All blocks below the general plane of the surface must be raised and more sand placed thereunder, and the blocks rammed again to an even bearing.

Bond stones with their upper surface set exactly to the grade or contour of the paving before ramming must be set in lines across the street at intervals of not more than 6 ft. and with at least three such stones in each line on a 30-ft. roadway and five on a 60-ft. roadway. Care in setting these stones and in paving to the lines defined by them will prevent the completed surface of the pavement having the wavy appearance so often seen.

Whether sand or grit is used for partly filling the joints before the paving cement is poured, care must be exercised in placing the sand or grit in the joints. Dumping a wheelbarrow load on the surface and then sweeping the joints full is absolutely forbidden.

Sand and grit or gravel should be dried before being used and put into the joints to as nearly as possible a uniform height as called for in the particular class of granite pavement.

RAMMING THE SURFACE—This part of the work is likely to be slighted unless carefully watched. The important thing is to have each block equally and sufficiently rammed to bring it to a solid bearing on the sand, as well as to bring its top to the proper grade. The rammers will be disposed to touch lightly blocks or areas which, if thoroughly rammed, would be driven below the true surface of the pavement, and subsequent travel may force these down, making depressions in the surface. The inspector must give this item of the work special attention.

❖

Extensions to the Ontario Hydro-Electric Power Commission's electricity-supply systems are to be built, with an appropriation of $2,500,000, which has recently passed the Ontario Legislature. Some $400,000 is needed for extensions to the Niagara district, $250,000 for new offices in Toronto, $200,000 for extensions of the Windsor service, $250,000 for the St. Lawrence district, $250,000 for Clinton and Goderich, $100,000 for Newmarket and north of Toronto, and $75,000 for Carrington and Beaverton. Also $150,000 of the appropriation is for extensions of the Severn River lines (in Simcoe and Grey Counties and independent of the Niagara supply), and $20,000 for the Port Arthur (Kiministiquia River independent) lines. The Commission proposes to do its own construction.

Recent press abstracts of the report of the Commission to the Ontario Legislature gives the total capital expenditure to Oct. 1, 1913, as $4,579,829, of which $4,158,829 was in the Niagara system alone.

New Harbor and Waterfront Works at Toronto, Ont.

One of the most extensive harbor developments on the Great Lakes is about to be undertaken at Toronto, Ont., under the immediate jurisdiction of a recently created Board of Harbor Commissioners working with funds provided by the City government, the Board itself and the Dominion government. For a number of years there has been in existence at Toronto a Harbor Board, but this Board had very limited powers and had not made any extended effort toward the development of the port and warehouse district. In 1911 an Act was secured from the Dominion government, incorporating a new Board of Harbor Commissioners, in which was vested very wide powers for the management and development of the harbor of Toronto, and the improvement of the city's waterfront generally. This Board has been engaged in the study of the harbor problem since its creation, and, on Nov. 14, 1912, submitted to the City Council and the Dominion government, plans for a development of the harbor to extend over a period of eight years, from 1912 to 1920. This plan was approved by both the contracting parties, and work has now started thereon. In the accompanying figures, there are given plans of the harbor at present, and of the development suggested by the Commission's design.

The main harbor of the city of Toronto is formed by a natural island about a mile and a half away from and parallel to the north shore of Lake Ontario, which forms the water edge of the city. This island, shown in Fig. 1, has been used for numerous industrial plants and as a recreation park. It is pierced along its west shore by an artificially made channel between jetties, and along its south shore by a similar channel, the former known as the Western Channel, the latter as the Eastern Channel. At its eastern extremity, there has been built a breakwater, which separates the main harbor from a portion of the harbor known as Ashbridge Bay, which is, in effect, merely a marsh, at present of little value for commercial purposes, and a decided disfigurement to that end of the city. This Ashbridge Bay territory was all vested in the city of Toronto, and as a principal contribution toward the improvement work which the harbor commissioners were expected to undertake, the city deeded to the commissioners all the land owned by it along the water front, including particularly the Ashbridge Bay district of 1000 acres. In addition to this district, there was also the bay shore of the island, many properties along the front of the inner harbor, and all the water lots on the lake front from Bathurst St. to the Humber River. This property has been valued at $9,000,000, and from it is derived a revenue of $65,000, the greater portion of it at the time of transfer being in an undeveloped state.

The new plans of the commission involve the formation of a new commercial warehouse district, a new dock development, and a new park and boulevard system. The plans may briefly be divided into three parts; (1) the industrial development in the Ashbridge Bay district, and along a 17-acre area at the foot of Bathurst St.; (2) a commercial and dock development at both these points and along the central waterfront in the middle of the harbor proper; and (3) park and boulevard improvements along the 12 miles of outer waterfront

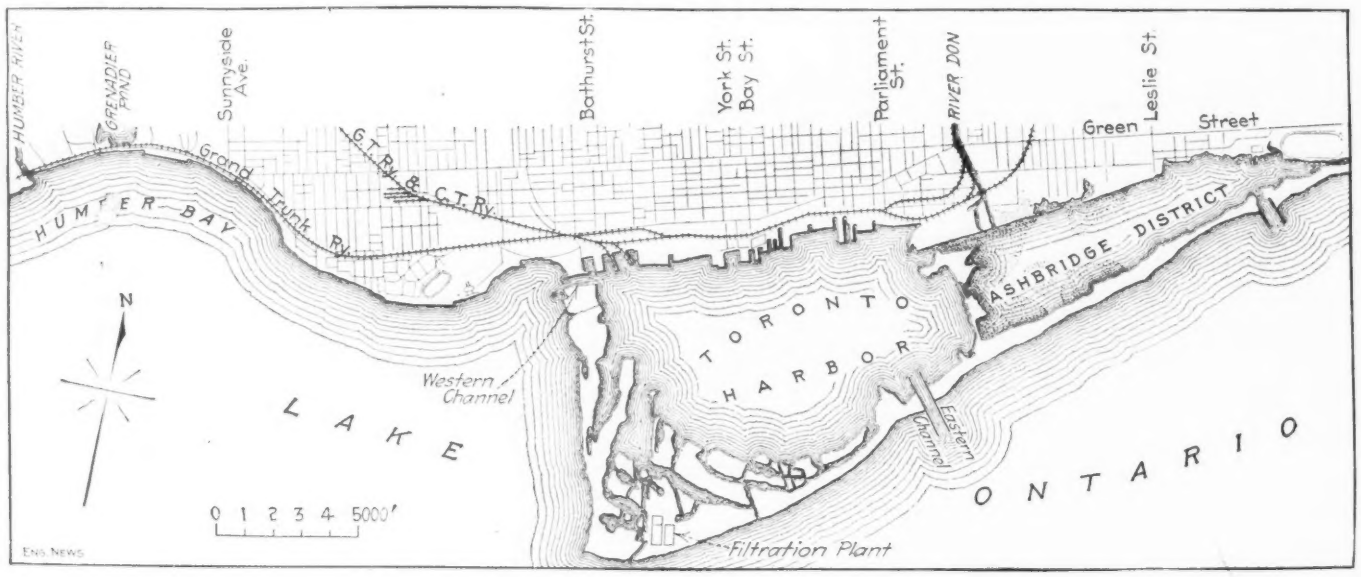


FIG. 1. MAP OF WATERFRONT AT TORONTO, ONT., AS IT NOW IS

from Woodbine Ave. along the outer bar, around the island to the Humber River at the extreme west of the city, with a protected waterway from the Humber on the west to Victoria Park on the east.

This entire project involves a total cost of $19,142,000, which is to be borne in the following amounts by the Dominion government, the city of Toronto and the harbor commissioners: City Council, $1,802,900; Dominion Government, $6,123,200; Harbor Commissioners, $11,215,900.

The engineer has estimated that the entire work can be carried to completion within eight years from the commencement of active operations. At least eighteen months was spent in a complete survey of the situation, which involved a hydrographic survey of the waterfront, and an involved study of the development. The resulting plans are outlined below.

PLANS FOR DEVELOPMENT

The harbor development is, for purposes of explanation, divided into three parts, as shown in Fig. 2. The Eastern Section includes all the district lying east of a line from Parliament St. to the eastern entrance to the

harbor, and extending east to the east city limits. The Central Section takes in the district between Parliament St. and Bathurst St., and includes the waterfront, the inner harbor, and the bay shore of the island. The Western Section deals with the property from Bathurst St. to the Humber River.

Eastern Section—The work projected for the Eastern Section includes all three classes of the development plan. The principal work will be the reclamation of the district known for many years as Ashbridge Bay, but which has been renamed, and will be in the future known as the Toronto Harbor Industrial District. Along the south face of this district there exists at the present time a low, narrow sandbar, which forms the north shore of Lake Ontario at this point. Many portions of this bar are frequently submerged during periods of high water. There is a constant shore erosion as a result of the heavy storms from the east which attack it. One of the most necessary portions of the work of carrying the harbor extension into the district is the protection of the shore. This will be done by means of a sea wall which will be constructed along the entire front, a distance of 4⅛ miles, and an average distance of 700 ft. south from the present shore line. With this protection assured, the work of reclaiming the marsh lands will be commenced, and the two works will be carried on at the same time, the filling being placed in the portion of the district behind each section of the wall, as the wall construction proceeds.

The whole eastern Industrial District will then be filled by dredging from the lake, which will require one of the largest dredging operations ever attempted on the lakes. Bids were asked for this dredging, to be opened May 28, 1913, work to commence Aug. 1, 1913. Advertisement states that the commissioners have in preparation plans and specifications for the removal of approximately 35,000,000 cu.yd. of material by hydraulic dredging, and that borings indicate 70% of material to be sand and gravel, and 30% a mixture of sand, silt and clay, which has to be delivered from the source of supply to a point of discharge at a maximum distance of about 6000 ft., and an average length of delivery of about 4000 ft. The dredges required for the work must be capable of handling at least 600 cu.yd per hour.

This filled-in area will be divided into two parts. The industrial area proper will be north of a line drawn east and west, and 1000 ft. back from the sea wall. This line will be marked by a street 66 ft. in width, which will divide the industrial district from the second part of the district, that is, the park area, to the south. Immediately south of this street will be a tier of lots 100 ft. in depth, and extending for over three miles along the north face of the park area, which lots are intended to be reserved as locations for summer homes. In front of the cottage reservations will be a park district and bathing beach, situated on a lagoon. This lagoon will be crossed by numerous foot bridges, in order to give the public free access to the park land, boulevard driveway and promenade, which will be constructed immediately behind the sea wall. The sea wall itself will be broken at intervals of 2000 ft. by openings 40 ft. wide, with 8 ft. of head room, which will allow small craft ingress and egress. Ample provision has been made for the erection of public bath houses, and for location of aquatic clubs along the beach.

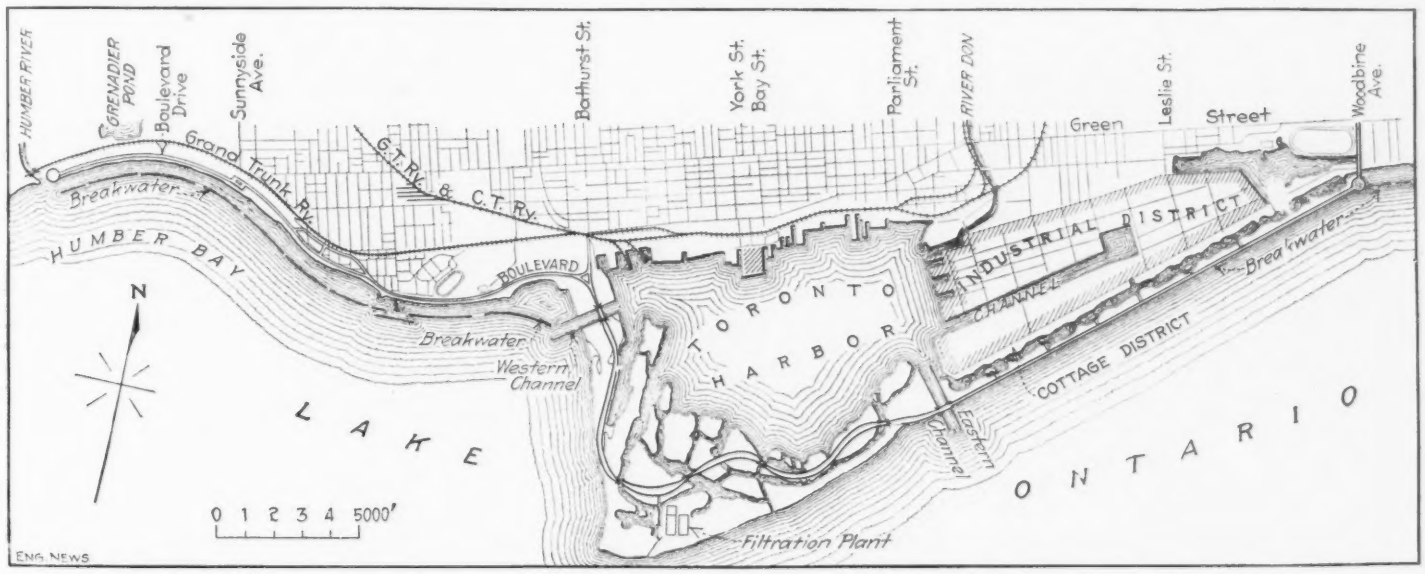


Fig. 2. Map of Waterfront at Toronto, Ont., as Planned by Harbor Commission

North of this roadway will lie the Industrial District, the development of which is so planned that when it is completed there will be 646 acres of land available for factory sites, 235 acres occupied by streets and railroad reservations, and 130 acres of waterways. The 30 miles of roadways will have a minimum width of 75 ft., and a maximum width of 175 ft. The district will be served by 30 miles of railway tracks, connecting with all three of the railroads which at present enter Toronto.

The railway layout has been so arranged that every alternate street will be free from tracks, and the siding service on the railroad reservations will be on a three-track system.

A ship channel will be constructed into the district for a distance of 6800 ft., terminating in a turning basin 1000 ft. square, and the sides of both the channel and turning basin will be so constructed as to form over 3½ miles of dockage accommodations. This channel will be 400 ft. wide, and the depth will be made to conform to the depth of the Welland Canal in order that any shipping which can enter Lake Ontario will be able to secure ample accommodations in Toronto Harbor.

The Welland Canal, it will be remembered, is being dug to a depth of 30 ft. over the miter sills of the locks.

The western, or bay face, of this Eastern Section, will be developed for dock purposes as the district grows, and will ultimately add two additional miles to the dock frontage of the area, as shown on the plan. One large dock is now being constructed, and will be equipped with modern freight sheds and a storage warehouse, and the first of a series of factory buildings will be erected back of the dock at an estimated cost of $409,000. The district has been so laid out that the area north of the ship channel will be reserved for light manufacturing plants. The area to the east of the turning basin will be the home of heavier plants, which do not require direct water access, while south of the channel will be located the heaviest class of manufacturing industries, which require a frontage direct on navigable water.

CENTRAL SECTION—In the central section, the work consists almost entirely of commercial and park developments, with one area covering 17 acres, at the foot of Bathurst St., suitable for industrial development The most urgent portion of the work is the encouragement of commerce by means of a proper wharfage service. This is now being provided at the east end of the harbor, by the new dock being constructed in the Eastern Section. Similarly, at the foot of Bathurst St., work is now being carried on, which will provide a dock with 20 ft. of water, behind which will be land suitable for light manufacturing plants, and also for the erection, by the commissioners, of a storage warehouse and a factory building, in which space will be rented to small manufacturing concerns. The sum of $409,000 will be expended by the commissioners in providing this warehouse and factory accommodation at this point. For the proper development of the central dockage facilities, the commission has planned to spend $1,785,000 in the construction of modern docks in the area from Bay St. to York St., with an adequate equipment of freight sheds and storage warehouses, but the details of this construction must be left until the question of the preparation of railway and highway grades has been definitely settled.

The other work planned for the Central Section consists of the reclamation of 352 acres of additional park lands on the island, a portion of which will serve as a location for the boulevard drive and the balance will include such portions of the island as are at present neither sightly nor useful. The driveway will be carried from the east across the Eastern Harbor Entrance by means of a roller-lift bridge, and will follow a winding course through the north portion of the island, crossing the lagoon by small bridges.

The Western Harbor Entrance, which is to be relocated, as shown in Figs. 1 and 2, will be crossed in the same manner, and on the large area of the land on the north and south of this entrance will be provided new park areas, and also a location for aquatic clubs, fronting on the western protected waterway.

WESTERN SECTION—From Bathurst St. west to the Humber River, the treatment is almost entirely shore protection and park-reclamation work, the only provision for development of a commercial nature being in the district from Sunnyside Crossing to the Humber, where a tier of lots is being reserved as a location for refreshment privileges and other amusement features which are incidental to the development of a summer resort watering place. A breakwater will be constructed from a point 200 ft. west of the north pier of the Western Channel, to the mouth of the Humber River, and distant an average of 900 ft. south from the existing shore line. This breakwater is needed to prevent the destruction of the shore and the lake shore road, which suffer heavily from southeast and southwest storms. Inside this breakwater will be a protected waterway with an average width of 500 ft., reaching from the Humber to Bathurst St., and linking up with the island lagoon system and the new lagoon system planned for the Eastern Section, so as to form a complete protected waterway 14 miles in length across the entire city front.

The old Western Harbor Entrance will be filled up and the boulevard driveway, after crossing the new Western Entrance, will be carried north to this newly filled land, from there divided into two branches, one branch running straight north to connect with Bathurst St., and the other continuing the driveway along the lake front to the west. A recreation and passenger dock, 300 ft. long and double decked, will be constructed at the Exhibition Grounds.

From Sunnyside Crossing to the Humber, a distance of slightly over a mile, provision will be made for a four-track radial railway entrance to the city from the west, on an elevation equal to that occupied by the Grand Trunk R.R. tracks. From these radial tracks, connections can be later made, if desired, with any subway system from Sunnyside Crossing to the center of the city. This reservation will be 80 ft. wide. The southern limit will be an average of 30 ft. south of the present lake shore road. Between this crossing and the Humber River, provision is to be made for a new summer resort, with boulevard, driveway, bridle path, bath houses and amusement features.

DIVISION OF COST

The City Council will construct the necessary highway bridge over the Don, to provide proper entrance to the Industrial District, and will build a retaining wall along the front of the Exhibition Grounds in the west, in order to separate the grounds from the boulevard, while the exhibition is in progress. They will follow up this initial work by undertaking the construction of necessary roadways, pavement and park features on the boulevard drive, including island bridges. The total cost of this portion of the work is estimated at $1,802,900.

The work allotted to the Dominion government is the construction of the ship channel and harbor expansion in the Industrial District, the necessary shore protection at the east end of the inner harbor, the construction of the breakwater from the Eastern Harbor Entrance to the east city limits, the construction of the breakwater from the Western Harbor Entrance to the Humber River, and the construction of the necessary lift bridges across the harbor entrances, and across the ship channel in the Industrial District. The cost of this work has been estimated at $6,123,200.

The balance of the work, which consists of the necessary dredging for reclamation purposes all across the entire front of the city, the filling of the Industrial District, construction of docks, freight sheds, warehouses, factory buildings, laying out of roadways and railway

reservations, construction of railroad facilities in the Industrial District, carrying out the development plan for the western summer resort section, is all to be under the charge of the Harbor Commission. The estimated cost is $11,215,900.

PERSONNEL

The new Commission consists of five members, all serving without remuneration, each appointed to serve for three years. Three of these are appointees of the City Council, L. H. Clarke, T. L. Church and R. H. Smith. One is a direct representative of the Dominion government, F. S. Spence, and one, R. S. Gourlay, is the representative of the Board of Trade, appointed by the Dominion government on the nomination of that board. The chief engineer for the Commission is E. L. Cousins, and J. G. Sing is the consulting engineer.

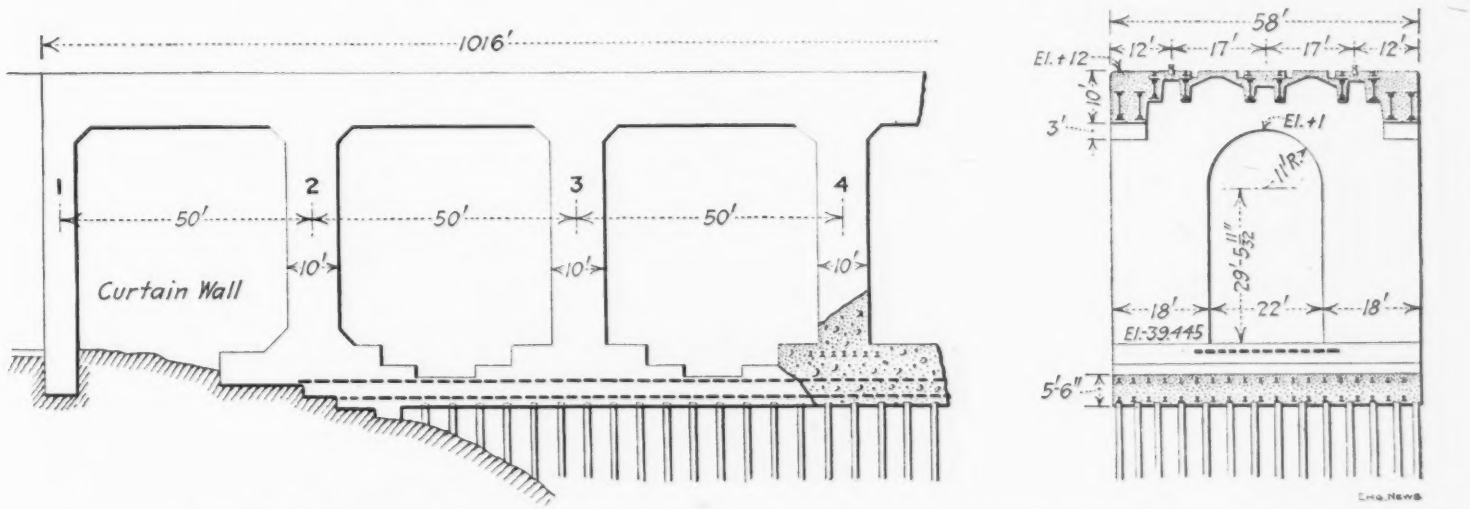
The Center Approach Wall for the Lower End of the Gatun Locks Panama Canal*

Because of the character of the foundation at the Gatun locks, the center approach wall on the sea side of the locks, which carries the tracks for the electric towing locomotives, will be constructed on an entirely different design from all the other lock and approach walls of the canal. The cellular form of reinforced-concrete wall used for the upper approaches at Gatun, Pedro Miguel and Miraflores was not used because of the possible effect of the salt water on the reinforcement. The gravity type of wall of U-section used for the lower center guide walls at Pedro Miguel and Miraflores, where they rest on rock foundation, is too heavy a construction for the mud foundation at Gatun, where, after excavation has been carried to a maximum depth of 50 ft. below sea level, the use of long piles is necessary to reach the underlying rock, which in places is 100 ft. below sea level.

To meet these conditions a steel, concrete-incased, causeway or viaduct, 1016 ft. long, from the line of the fender chains to the outer end, is being built on 20 concrete piers 50 ft. c. to c., which rest on a continuous reinforced-concrete slab supported on piles. The spans connecting the piers are carried by four steel plate-girders 6 ft. in depth and six plate-girders 4 ft. 6 in. in depth, arranged as shown in the accompanying illustration. The six spans nearest the locks are closed by 2-ft. curtain walls to prevent the water from surging from one approach channel to the other, between the piers, when one lock is discharging.

The original plans provided for piers resting on broad bases surmounting the piles. However, excavation revealed softness in the earth overlying the rock, which was not shown by the borings made at the time of determining the lock site, making it necessary to bind the piers together to protect them against transverse sliding. The foundation piles are driven on 4-ft. centers, longitudinally and transversely (on 3-ft. centers for the outermost 200 ft.) and are surmounted by a continuous slab of concrete which extends a foot below the top of the piles.

This base slab is 58 ft. wide with a level bottom. The top of the slab is a series of inverted stepped arches. The haunches between the successive inverted arches form the bases of the piers. At the lowest step of the inverted arches, the thickness of the base slab is 5 ft. 6 in.; at the springing line it is 10 ft. 6 in. Several of the arches were constructed with the soffit on a curve, but for the sake of speed in construction and consequent economy, as well as to afford a better bracing for the forms in the erection of the piers, the stepped arch was adopted. The lower part of each riser is on the circumference of a regular segment, of 42-ft. radius, so the strength of the arch is not diminished. Reinforcement in the base consists of 20 longitudinal rows of 70-lb. rails resting on a level with the tops of the piles and a similar row 3 ft. 6 in., c. to c., above.



ELEVATION AND SECTION OF CENTER APPROACH WALL, GATUN LOCKS, PANAMA CANAL

Each pier, as shown, is an arched structure. The rectangular piers supporting the arch are 10x18 ft. in cross-section and the semicircular arch span between is 22 ft. The bottom of the arch opening is at an elevation—39.37 ft., and the top of the wall is 12 ft. above sea level.

The foundation was completed during the first week in April, appeared to be firm, and the erection of the superstructure is being pushed.

The completion of this foundation, assuring steady progress on the approach wall, has important bearing on the date of completion of the canal.

*Based on article in the "Canal Record" of Apr. 2 and Apr. 16.

Excavation for its site had been carried to 51 ft. below sea level when, on Jan. 25, a large slide from the east bank carried away tracks, overthrew machinery and covered the site with a layer of mud averaging 10 ft. thick.

In further developments the sliding threatened the work with delay. Any slides which may occur hereafter at this point will cause no interference. The placing of concrete will go on, and the sliding material will be removed by dredges after water is let in from the Atlantic entrance channel.

Establishing Ex-Post-Facto Gage Heights

By C. F. Brown*

SYNOPSIS—Observed lake heights at the entrance of a river and also the volume discharged from the lake were employed in an alleged flood damage case to deduce river heights on a tributary of the lake at a point 15 miles above the lake. Subsequently, gage heights were available at the river station, so the deduced and the actual gage heights could be compared.

The problem which confronted the writer of this article was that of the probable daily gage heights of a river for a series of years during which there had been no continuous observations at the point in question. The necessities arose through the construction of a bear-trap dam at the outlet of Cœur d'Alene Lake, Idaho, and the question as to the effect of the same on lands along the St. Joe River, a tributary of the lake, in the vicinity of St. Maries, a point 15 miles above the mouth of the river at Chatcolet, the head of the lake (see Fig. 1).

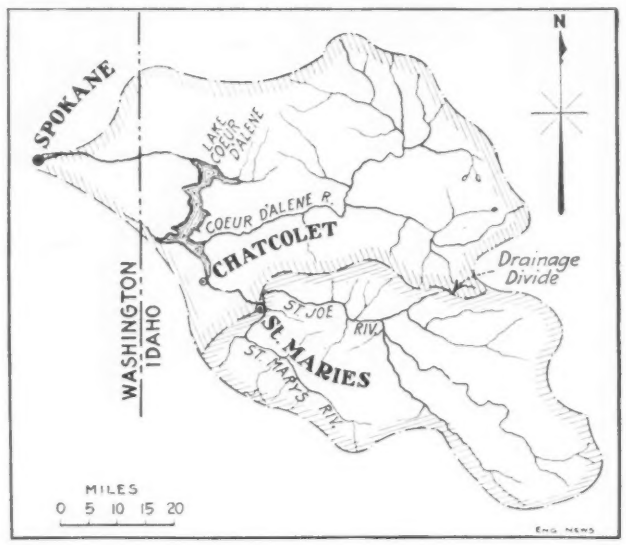


Fig. 1. Sketch Map of Lake Cœur d'Alene, Idaho, and Tributary Streams.

It was admitted that the operation of the dam, the crest of which had a mean sea-level elevation of 2126.5, and which was to be raised only when the level of the lake receded to this elevation, would tend to retard the rate of lowering of the lake by making it a storage reservoir during the summer months. It was also conceded that lands adjoining the lake and along the river might be injured somewhat to Elev. 2128. The new dam had a discharge capacity 41% greater at the second highest flood stage than the old dam when open, decreasing somewhat as the flood height decreased, but at all times a discharge capacity greater than that of the old structure. The crest and bottom openings had elevations ranging from 2108.6 to 2116.5, as against a crest on the old dam of 2116.5.

It was claimed by the land interests that the raising of the dam during the summer months, beginning about July 1, tended to cause a piling up of the waters during the flood season and also during the time the bear traps were up; that is to say, that there were greater differences between the surface of the water in Cœur d'Alene Lake and the surface of the water in the St. Joe River at St. Maries, and consequently on the adjoining low lands, than there had been in years previous, and that the extent of injury to the river lands could not be shown from a comparison of the lake elevations and elevations of the lands in question. This assertion was not made by engineers, but by laymen, and constituted one of the claims for damages.

As shown by Fig. 2, the cross-section of the St. Joe River is unusually large and the gradient very low for all but extreme flood discharges. It was the opinion of the

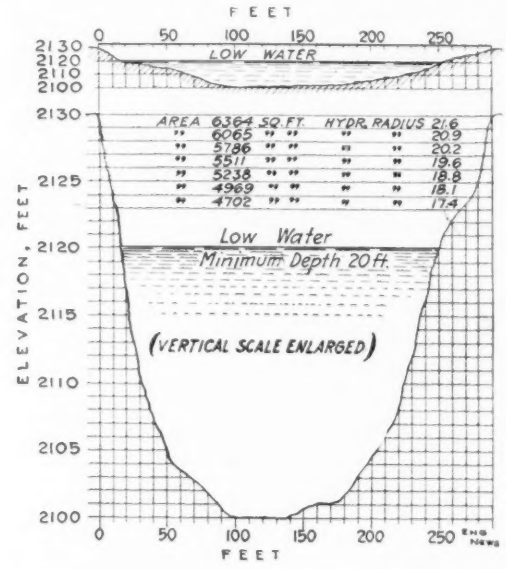


Fig. 2. Typical Cross-Section of St. Joe River, Idaho, St. Maries to Chatcolet

writer that because of this a direct relation could be established between elevations of the Lake and elevations of the river at St. Maries.

Hence the immediate object of this phase of the investigation was to show that the elevation of the water in the river at St. Maries was practically coincident with the lake levels at all seasons of the year excepting the periods of maximum runoff, and had been for many years previous to and since the construction of the dam, which in turn was evidence that the adjoining lands had not been injured by the construction and operation of the

*Of Brown & Kleinschmidt, Civil and Consulting Engineers, Dooly Block, Salt Lake City, Utah.

FIG. 3. VALLEY OF ST. JOE RIVER AT ST. MARIES, IDAHO; LOOKING DOWNSTREAM

dam more than was shown by the curves of lake elevation.

The river valley lands have been built up by sediment from the river which has overflowed its banks annually. As a result the lands are found to have elevations from 2126 to 2128, with narrow banks along the river ranging from 200 to 500 ft. in width, and from 2 to 3 ft. higher than the average of the lands (see view, Fig. 3) and valley with St. Maries on the left, looking downstream.

Daily gage readings showing the fluctuations of the lake at Chatcolet had been kept by disinterested parties from Apr. 26, 1903. The dam was put into operation for the first time July 29, 1907. Referring to the diagram of gage heights of Cœur d'Alene Lake (Fig. 4) the effect on the lake elevations is shown by the two groups of curves between July 1 and Nov. 6, the lower group representing the years previous to, and the higher group those since the construction of the dam.

The runoff from this river system is influenced very largely by heavy snows in the mountains and the effect of the warm Chinook winds. The annual precipitation at St. Maries, on the lower edge of the basin, is 20 in., most of which falls in the form of snow. The elevation of the cachment basin varies from 2150 at St. Maries to altitudes upward of 7000 for the mountain crests. As usual in these latitudes, the precipitation varies directly as the altitudes, so that the precipitation of the mountains is probably 50 in. During the years 1891-6 the runoff from the total Spokane River Basin at Spokane, Wash., varied from 18.4 to 33.3 in., with 22.3 in. for the year 1909. Of this runoff over 50% occurs during the months of April, May and June, without taking into account the storage effect of the lake, and but for this a still higher runoff would be shown from the mountains during this period. These years are used for illustrative purposes, as the discharges are summarized in "Water-Supply Paper" No. 272, U. S. Geological Survey.

The basin is densely timbered, preventing the formation of extensive snow drifts and packs, and contributing to maximum discharges when the Chinook winds are accompanied by rain.

The river channel is peculiarly adapted to computations involving discharges and slope by reason of its very uniform section and bottom grade. The minimum depth is 20 ft. in low stages, with the surface elevation at 2120, and during the highest flood it reaches 35 ft., or an elevation of 2135 at St. Maries. At the low stage the width averages 250 ft., with 300 ft. between banks at an elevation of 2130. The river overflows its banks on the lower portions at Elev. 2128, but the average bank elevation is 2130. The banks have been eroded some by steamboats so that in places there are obstructions in the form of trees, willows, etc., along the sides.

A survey of the basic data on which the solution of the problem depended shows:

(1) Observed daily gage heights of Cœur d'Alene Lake, 1903-10.

(2) Observed daily discharges of the Spokane River at Spokane, showing discharges from Cœur d'Alene Lake.

(3) Land surveys and topographic surveys of adjoining low lands, from which mean areas of the latter were determined.

From these data it was possible to arrive at the mean daily inflow into the Cœur d'Alene Lake drainage basin. The mean daily discharge of the St. Joe River was then determined by proportion from the total inflow as the ratio of the St. Joe drainage basin above St. Maries to the total drainage basin of the Spokane River at Spokane. These areas were obtained from the United States topographic maps. The uniformity of the cachment basin in all its essential features affecting runoff made such a relation as is described above sufficient for the degree of accuracy required.

In casting about for a formula of the flow of water in rivers from which the relation of the slope or hydraulic gradient to the discharge could be graphically expressed,

the Chezy formula with Kutter's coefficient naturally came first to mind. A simple inspection showed that our desired expression was a pure quadratic equation, but very unwieldy, especially with reference to the hydraulic radius, which precluded its use at all for the purpose at hand.

We next had recourse to the experimental formula of the form $V = C\, r^{.67}\, s^{.54}$, which in addition to being capable of solution by logarithms, has a more constant value of C for the same channel and different velocities.

In comparing the methods used in this solution, the reader is requested to withhold judgment as to mathematical accuracy and to keep in mind the accuracy required. The sufficiency of the computations will be shown later in comparison with actual gage readings made subsequently.

The method employed in arriving at the daily discharge of the river for the eight years will be described

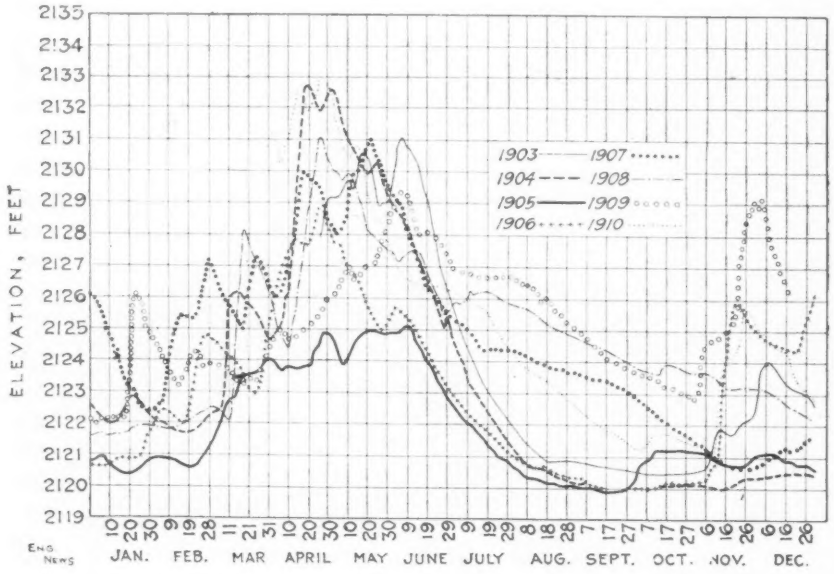


FIG. 4. GAGE HEIGHTS OF CŒUR D'ALENE LAKE, AT CHATCOLET, IDAHO, 1903-10

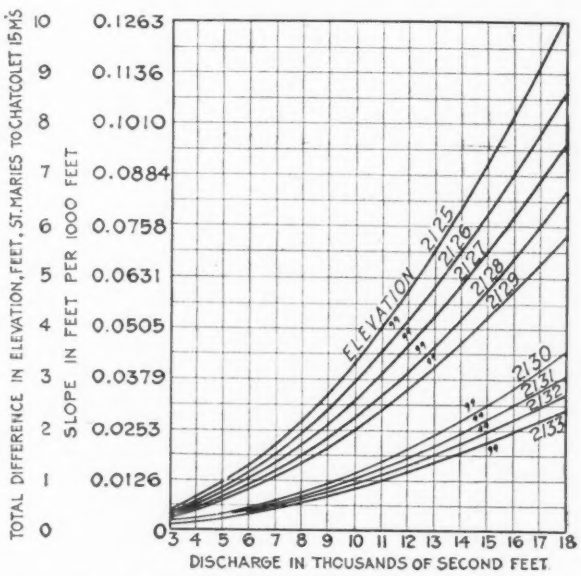


FIG. 5. SLOPE-DISCHARGE CURVES FOR ST. JOE RIVER, ST. MARIES TO CHATCOLET
(Elevations at St. Maries.)

in some detail. The areas given below were used in the equations which follow:

Cœur d'Alene Lake Drainage Area, 3530 sq.mi.

St. Joe and St. Maries Rivers Drainage Area, 1690 sq.mi.

Area of Cœur d'Alene Lake, Rivers, etc., elevation under 2128, 27,448 acres.

Area of Cœur d'Alene Lake, Rivers, etc., elevation over 2128, 49,784 acres.

By proportion then,

$$\frac{\textit{St. Joe River discharge}}{\textit{Total inflow}} = \frac{1690}{3530}$$

or the St. Joe River Discharge = 0.478 Total Inflow.

To determine the total inflow two equations were necessary:

(1) For lake rising, with elevation under 2128.

Total Inflow = Spokane River Discharge + 13,724* × Daily Rise of lake in ft.

For lake rising, with lake elevation above 2128.

Total Inflow = Spokane River Discharge + 24,892* × Daily Rise of lake in ft.

(2) For lake falling, with lake elevation under 2128.

Total Inflow = Spokane River Discharge − 13,724* × Daily Fall of lake in ft.

For lake falling, with lake elevation above 2128.

Total Inflow = Spokane River Discharge − 24,892* × Daily Fall of lake in ft.

The Spokane River discharges were taken from curves of discharges at hand and the fluctuations of the lake from the curve of observed daily gage heights shown on Fig. 4. The several multiplications and divisions involved were made by a Brunsvega calculating machine and the slide rule.

Observations of velocity during maximum discharge showed that the water flowing out of the lake passed Spokane one day later on an average and that there was also one day's difference between St. Maries and the lake, the Spokane River being precipitous while the St. Joe is sluggish. Consequently in arriving at the discharge of the St. Joe River at St. Maries, the discharge of the Spokane River at Spokane two days following was used, while the discharge as indicated by the fluctuations of the lake was taken of one day following.

Knowing the mean daily discharge of the St. Joe River, the next step involved was that of preparing a set of curves from which the total difference in elevation between the lake and the river at St. Maries corresponding to the different discharges could be taken and added to the lake curves for the final curve of gage heights at St. Maries. Referring again to the formula

$$V = Cr^{.67}s^{.54}, \text{ or } s = \sqrt[.54]{\frac{Q}{ACr^{.67}}}$$

it will be observed that a number of such curves will be necessary as the area of the waterway and consequently the hydraulic radius vary as the depth, which in turn is dependent upon the lake elevation. Accordingly, several sections were made of the river in different places, showing remarkable uniformity. One such section selected for use is shown in Fig. 2. It will be noted that the area and hydraulic radius for each foot of elevation from 2125 to 2133 are shown.

With these and observed slopes at nearly all stages of

*Area of the lake in acres divided by 2, reducing acre-feet to second-feet since 1 cu.ft. per sec. or 1 sec.-ft. equals 2 acre-ft. (nearly) in 24 hours.

elevation and discharge, 8 solutions of the formula

$$C = \frac{Q}{A\, r^{.67} s^{.54}}$$

another transposition of the exponential formula were made, giving values of C ranging from 59 to 70, an average value of 66 being taken when the river was within its banks. For elevations above 2130 when the river overflowed its banks C was found to have a value of 80.

The term $A\ C\ r^{.67}$ is a constant for each elevation and was calculated and designated as K_1, K_2, etc. The "Slope Discharge" curves were then made up by computing slopes for discharges of 3000, 6000, 9000, 12,000, 15,000 and 18,000 sec.-ft., passing through the channel at the different lake elevations from 2125 to 2133, and the points were platted in rectangular coördinates and the curves drawn as shown by Fig. 5.

Deriving the daily discharge of the St. Joe River at St. Maries by proportion from the observed discharge of the Spokane River at Spokane, and having the daily observed gage heights of Cœur d'Alene Lake, by use of the "Slope Discharge" curves (Fig. 5), the fall corresponding to any lake stage and derived discharge of the St. Joe River was obtained. The final curves (Fig. 6) were then made by adding these differences in elevation to the lake elevations for each day, making "Derived Daily Gage Heights" of the St. Joe River at St. Maries.

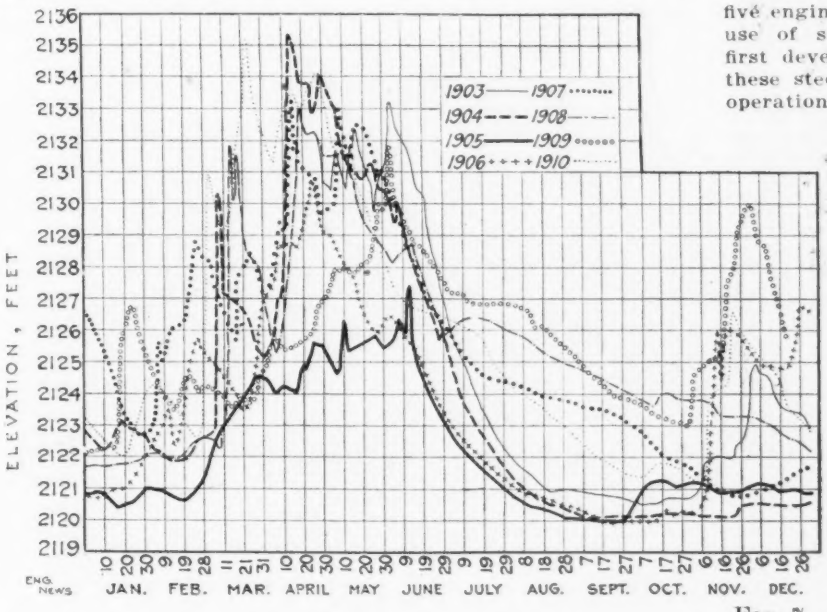


FIG. 6. DERIVED GAGE HEIGHTS OF ST. JOE RIVER AT ST. MARIES, IDAHO, 1903-10

Daily observations of gage heights had been made at St. Maries for the year 1911 which afforded a means of comparing the derived gage heights with actual gage heights. For this purpose the gage readings for 1911 were derived as for previous years and platted on the same sheet, as were the actual gage heights for that year (see Fig. 7). The gage readings of the lake are also platted on this sheet to show the general relation of the two. As would be expected the peaks of the derived gage heights are slightly lower than the actual peaks. It must be agreed, however, that the results show a remarkable agreement, and one which justified the effort.

Coming now to the practical value of these derived curves, they show:

(1) That the only appreciable or significant differences between the elevations of the river at points near St. Maries and elevations of the lake occur during the flood period or during the months of April, May and June, sometimes beginning in March; and that during the remainder of the year and especially during the summer and fall months, the daily elevations of the river and lake are coincident.

(2) That the damages to the lands and crops on the lands at elevations higher than 2128 are the results of the late spring floods, separately and apart from the effect of the new dam.

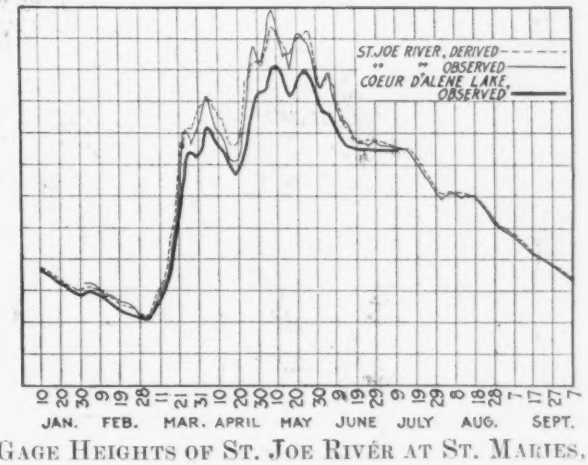


FIG. 7. GAGE HEIGHTS OF ST. JOE RIVER AT ST. MARIES, IDAHO, AND OF CŒUR D'ALENE LAKE AT CHATCOLET, IDAHO, JANUARY-SEPTEMBER, 1911

Five Blast-Furnace Blowing Engines, each with a capacity of 20,000 cu.ft. of free air per minute, operated by gas engines using blast-furnace gas, are to be built for the Maryland Steel Co. by the Bethlehem Steel Co., of South Bethlehem, Penn. The engines have double-acting gas cylinders in line with the blowing cylinders, and are similar in type to those now in operation in the Bethlehem Steel Co.'s own plant. The gas engines have cast-steel cylinders, 45 in. diameter and 60 in. stroke, which are the largest gas-engine cylinders ever cast in this country. The Bethlehem Co. is also building five engines of identical size for the Minnesota Steel Co. The use of steel castings for these very large cylinders was first developed by the Bethlehem Steel Co., and the first of these steel gas-engine cylinders has now been in successful operation for four years.

Sanitary Legislation in Indiana in 1913 has been summarized for this journal by Dr. J. N. Hurty, Secretary of the Indiana State Board of Health. The law of most interest to engineers was one which empowers the State Board of Health to order the installation of water filtration plants wherever the Board deems such a course necessary. The most important public health law passed in 1913, Dr. Hurty states, is a very comprehensive Housing measure. Among its features are prohibitions of inside rooms, or rooms without windows opening to the outer air. Another bill strengthens the old vital statistics law requiring the reporting of births, deaths, and contagious diseases. Dr. Hurty states that the bill makes the old law "almost perfect." A law of particular interest and with a somewhat facetious popular name, taken both from a part of its subject matter and from the introducer of the bill, is known as the "Rat Law." This bill was introduced by Senator Oscar Ratts, of Paoli. It authorizes health officers to enter upon any lands, buildings or vessels to ascertain whether or not they are infested with rats. Owners of buildings may be formally notified to clear their premises of rats and make premises rat-proof. The same law also provides for the teaching of anatomy, physiology and hygiene of the human system; the effects of alcohol and nicotine; the cause and course of consumption, and the dissemination of diseases by rats, flies and mosquitoes. Still another law authorizes cities of 20,000 inhabitants or more to raise funds for and to build public baths and swimming pools. The Lake Michigan Sanitary District Law, applicable to the counties bordering on Lake Michigan, creates a sanitary district, to be administered by five trustees appointed by the Governor. It is estimated that the contemplated sewerage and drainage work will cost $2,000,000.

Performance of a 450-H.P. Boiler with Oil Fuel

By A. L. Menzin*

There was recently completed at the U. S. Navy Yard, Mare Island, Calif., a modern steam power plant to supersede old equipment for furnishing compressed air and electric power about the navy yard. The new equipment is housed in a handsome building of reinforced concrete and brick, and includes two 5000-cu.ft. steam-driven air compressors, two 500-kw. and one 1000-kw. turbo-generators, eight 450-hp. water-tube boilers equipped with superheaters, a complete oil-burning system, and the necessary auxiliaries.

In comparing the various bids received for furnishing and installing the boiler plant, the government made rational allowances for the differences between the respective guaranteed efficiencies and the lowest considered, by correcting the price named in each bid by an amount equal to the present worth of the corresponding saving in fuel—the total period of operation and the cost of fuel being assumed. The guaranteed performance was therefore an important factor in awarding the contract, in consequence of which the contractor was made liable to a proportional penalty should the actual performance be inferior to that guaranteed.

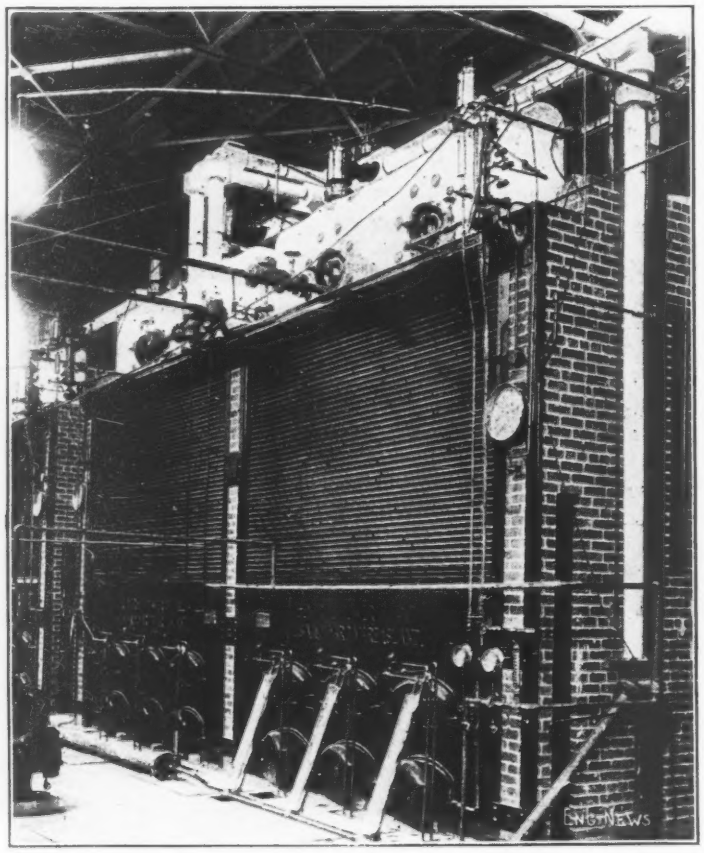


Fig. 1. Front of Oil-Fired Water-Tube Boiler at Mare Island Navy Yard, under Test

The efficiency at about rating guaranteed by the successful bidder, the Edge Moor Iron Co., of Edge Moor, Del., was 80%. Other important guarantees referred to moisture in the steam passing into the superheater, and to steam used by the oil burners for atomization. All guarantees were met in the first series of tests—the principal data and results of which are given below.

The tests were made under the direction of a board of naval officers consisting of Messrs. Fred Thompson, Civil Engineer, U. S. N. (chairman), A. H. Van Keuren, U. S. Naval Constructor; and Lieut. Harold Jones. Geo. A. McKay, Public Works Officer, under whose direction the plant was installed, coöperated with this board. The contractor was represented by the writer.

Owing to the pecuniary penalty involved, great care was taken to assure the reliability of all readings. The correctness of the testing apparatus was determined by suitable methods by, or in the presence of, representatives of both the government and the contractor. The water was weighed in all the tests. In the test for efficiency, the fuel oil was weighed; in other tests, in which the oil used was not involved, the oil was measured with a calibrated piston-type meter.

TEST AT ABOUT RATING

Date of trial	Oct. 11, 1912
Duration of trial	10 hr.
Dimensions and Proportions	
Name and type of boiler: Edge Moor water tube	
Number of drums in boiler	2
Number of tubes wide	17
Number of tubes high	14
Total number of 4-in. tubes 18 ft. long	231
Water heating surface, sq.ft.	4585
Name of superheater: Foster	
Superheating surface, sq.ft. (external surface of tubes only)	222
Name and type of oil burners: Owens inside mixer	
Number of burners to one boiler	3
Area of air spaces in furnace floor, approx., sq.in.	1140
Area of air spaces per horsepower of rating, approx., sq.in.	2.5
Average Pressures	
Barometer, in., Hg.	30.15
Steam pressure by gage, lb. per sq.in.	145.6
Pressure of oil to burners, lb. per sq.in.	47.5
Force of draft at damper, in. water	0.19
Force of draft in ash pit, in. water	0.15
Average Temperatures (F)	
Of external air	70°
Of air passing into ash pit	82°
Of steam	455.4°
Of feed water entering boiler	170.8°
Of escaping gases from boiler	421.0°
Of oil supplied to burners	127.1°
Fuel	
Kind of: California crude oil	
Specific gravity, oil freed from water, grit and other foreign matter	0.9504
Gravity, Baumé scale	17.30°
Percentage by weight of water in oil	0.42%
Percentage by weight of grit and other foreign matter in oil	0.034%
Calorific value of one pound of pure oil with water vapor due to hydrogen content uncondensed, B.t.u.	17,605
Calorific value with water vapor condensed (heat value as commonly given), B.t.u.	18,790
Quality of Steam	
Percentage of moisture in steam passing into superheater	0.06%
Superheat of steam passing out of superheater (F)	89.9°
Hourly Quantities and Rates	
Pure oil consumed, lb. per hr.	1,008.1
Water evaporated, lb. per hr., corrected for discharge through calorimeter	13,939.8
Equivalent evaporation, lb. per hr. from and at 212°	16,001.5
Equivalent evaporation per hr. from and at 212°, lb. per sq.ft. of water heating surface	3.49
Factor of evaporation	1.1479
Horsepower	
Horsepower developed	463.8
Rated horsepower (10 sq.ft. of water heating surface per horsepower)	458.5
Percentage of rating developed	101.2%
Economic Results	
Water apparently evaporated under actual conditions, lb. per lb. of oil as fired	13.77
Equivalent evaporation, from and at 212°, lb. per lb. of oil as fired	15.80
Equivalent evaporation, from and at 212°, lb. per lb. of pure oil	15.87
Equivalent evaporation, lb. per lb. of oil based on a standard calorific value of 18,500 B.t.u.	15.62
Efficiency	
Efficiency of boiler based on calorific value of oil with water vapor due to hydrogen content uncondensed	87.1%
Efficiency (as ordinarily given) based on calorific value of oil with water vapor condensed	81.6%
Smoke Observations and Gas Analysis	
Gases issuing from stack were just barely visible during entire test	
Minimum percentage of CO_2 at damper by Orsat apparatus	12.5%
Maximum percentage of CO_2 at damper	13.4%
Steam Required by Burners	
Steam used by burners to atomize 1 lb. of oil as fired	0.32 lb.
Percentage of steam generated used by oil burners for atomization	2.33%

*Testing Engineer, Edge Moor Iron Co., Edge Moor, Del.

For determining the steam used by the oil burners the orifice method was employed. The apparatus is shown at the right in Fig. 1. A hole made with a $\frac{5}{16}$-in. drill in a common pipe plug constituted the orifice. This was located in the flange union between gages. The apparatus was calibrated with tank and scales in the usual manner before the tests were run.

The government detailed men from its testing laboratory and engineering departments at Mare Island to observe and record all readings. The contractor also furnished two men for duty on the weighing platform so that all weights could be certified to by a representative of each party. The weighers and checkers were required to place their initials after each recorded weight as a precaution against errors. The weighing was done under the personal direction of W. A. Lynn, engineer in charge of the electrical laboratory at Mare Island. Temperatures, pressures, etc., were recorded by observers for the government and were occasionally checked by the contractor's engineer.

In the efficiency test, the weighing was conducted so that the weights of oil and water used during each hour could be determined. Pressures, temperatures, etc., were recorded every 15 minutes. The observers used specially prepared forms and by means of carbon paper recorded all readings in duplicate. Representatives of the respective parties interested were therefore able to compute the results of the tests independently from original records. After the computations were made the results were compared and checked.

All tests were made on one boiler selected by the government after the installation was completed and in operation. The blow-off piping and feed-water piping to boiler and superheater were disconnected from respective headers to avoid errors from leakage.

The factor of evaporation, equivalent evaporation and efficiencies given above are based on Marks and Davis' steam tables (1912 edition) and are slightly lower than the corresponding official results on account of the high specific heat of superheated steam specified in the contract. This was given as 0.65, which conforms to older practice.

The efficiency obtained in this test is remarkably good especially when it is considered that the firing was done by the regular government fireman who depended entirely on his eyesight for guidance in making the adjustments necessary for good combustion. He was cautioned about the firing probably not more than three or four times during the entire ten-hour run. The essentials for efficient performance, namely low temperature of outgoing gases and high percentage of CO_2 at damper, were present.

It will be noticed that two efficiencies of the boiler are given. These are in terms of the calorific values of the oil with water vapor due to the hydrogen content uncondensed and condensed as determined by the chemists. For commercial purposes it would seem to be more logical to consider the efficiency based on the first named calorific value, since the latent heat in the steam produced by the combustion of the hydrogen content is not commercially available for making steam. To utilize this latent heat would require a reduction of the temperature of the flue gases to 212° F. or less, which does not seem to be feasible even with economizers. When the fuel used is relatively low in hydrogen and the efficiency of the boiler is based on the "high" heat value, the boiler is unfairly favored by having a smaller amount of unavailable heat charged up to it. A comparison of boiler efficiencies based on the high heat value of the fuel is therefore not sufficient for determining the comparative performance of steam boilers.

It has been pointed out (Trans. Am. Soc. M. E., Vol. 33, p. 68) that there appears to be no exact relationship between the hydrogen content and the specific gravity of California oils, and that individual analysis is necessary. Very few data bearing on this point seem to have been published but, from those available, it would seem that there is a sufficient variation in hydrogen to warrant taking it into consideration when making guarantees, especially when a bonus or penalty is involved.

Besides the test for efficiency at rating, other tests of short duration were made to determine the characteristics of certain parts of the equipment at different rates of evaporation. The percentage of moisture in the steam passing into the superheater as determined by a throttling calorimeter was found to be 0.22% at 196% of rating as against 0.06% at 101.2% of rating. The performance of the superheater is shown in the following table:

Percentage of rating developed	61.4%	101.2%	196%
Superheat	92° F	90° F	118° F

The superheat produced by a given superheater de-

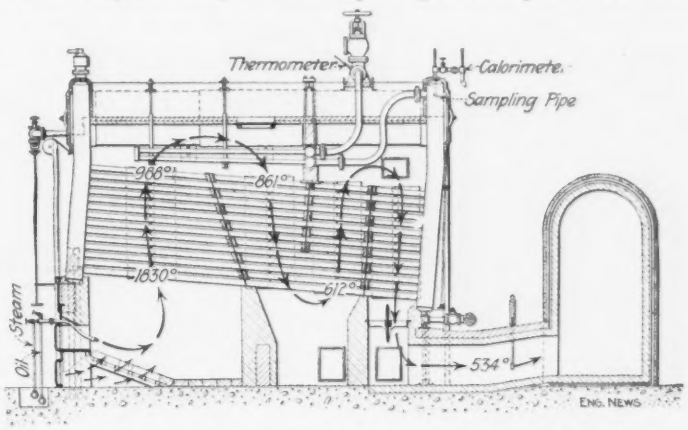


FIG. 2. SECTIONAL ELEVATION OF OIL-FIRED WATER-TUBE BOILER AT MARE ISLAND NAVY YARD

pends not only on the rate of evaporation but also on the character of combustion. With a given rate of evaporation too little or too much air will affect the average temperature of the gases passing through the superheater and the superheat will be affected accordingly.

The following table shows the steam used by the oil burners for atomization:

Horsepower developed by one burner	94	155	238	300
Pressure of oil, lb. per sq.in.	39	47.5	78	84
Temperature of oil, F°	127	127	91	90
Efficiency of boiler		81.6%		
Steam required for atomization, lb. per lb. of oil	*0.30	0.32	*0.20	*0.17
Percentage of steam generated used by by burners for atomization	2.4%	2.33%	1.8%	1.5%

* Oil measured by meter and weight computed.

The steam used by an oil burner depends, of course, within limits, on the care taken by the fireman in adjusting the steam valve. This adjustment is not a delicate one, and if a fireman is careless he can use a great deal more steam than is required—which is not only a waste but which may also cause damage to the tubes by blowing the flame up against them. The inside mixer type of burner is somewhat proof against such carelessness as too much steam raises the pressure in the mixing chamber which cuts down the supply of oil and therefore the fire.

Fig. 2 shows the fall of temperature of the gases through the boiler when operated at about 196% of rating. Temperatures taken with the boiler operating at about rating would probably be of more interest but, unfortunately, a complete set of readings was not taken during this test. However, those taken permit of a comparison of the temperatures at certain points, which is given below:

Percentage of rating developed	101.2%	196%
Temperature between 1st and 2d rows of tubes over furnace, F	1560°	1830°
Temperature at top of fizst pass	686°	988°
Temperature of gases passing out of boiler	421°	534°

The temperatures given above are the averages of several readings. All temperatures in the setting were taken with a Bristol electric pyrometer with bare thermo-couples set at approximately 30 in. from the inner face

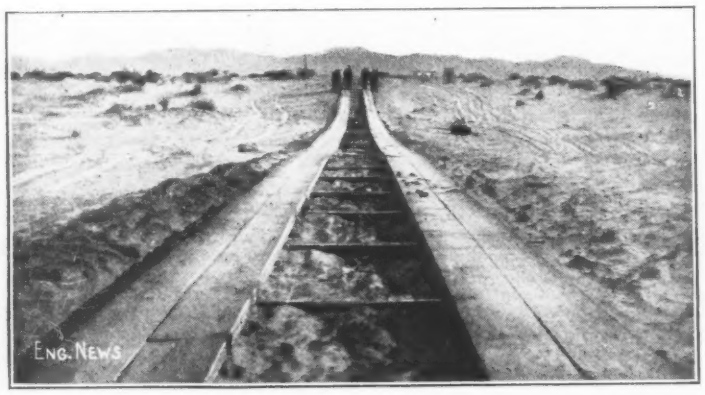


Fig. 1. Plank Road Across the Desert near Blythe, Calif., for Motor Truck and Team Haulage
(Ready for sand filling between wheel tracks.)

of the boiler wall. The thermo-couples were set by trial to give the highest temperatures, which corresponds to a setting where the cooling effect of radiation from the thermo-couple to the tubes is a minimum. All temperatures taken with the pyrometer are corrected for air temperature at the junction of the fire end with the extension piece. The temperature of the outgoing gases was taken with a mercury thermometer located as shown in the drawing. Temperatures near the damper taken with the pyrometer practically agreed with those indicated by the mercury thermometer.

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Grounding of Low-Potential Alternating-Current Circuits to prevent transmission of dangerous voltages to persons temporarily in contact with fixtures on the low-potential line, as noted in "Engineering News," Apr. 24, 1913, and May 9, 1912, is now made mandatory by a revised rule in the National Electric Code of the National Fire Protection Association, governing the insurance investigation of electrical installation. This is Rule 15, which now requires grounding of transformer-secondary and direct-current circuits provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 150 volts. It permits, but does not demand, the grounding of circuits where such potential exceeds 150 volts. For industrial private plants, not connected to a public distributing system and thoroughly insulated, grounding is not required. The rule recommends that the ground connection shall be placed on complete metallic underground piping systems, and urges water companies and water departments to allow the attaching of ground wires to their piping systems in full confidence that the integrity of the piping system will not in any way be affected.

This rule, like all others of the National Fire Protection Association, is not retroactive, and applies to work to be done after the new electrical code is printed and distributed, which is expected to be about June 1.

Improving Desert Roads for Motor-Truck Haulage

A motor-truck service for freight haulage between Blythe, Calif., and Blythe Junction, on the Atchison, Topeka & Santa Fé Ry., has been put in operation by the Santa Fé & Blythe Motor Transit Co., and in connection with this the company has done some road work of an unusual and interesting character. A large part of the distance is over a sandy desert, and it was necessary to form some kind of substantial roadbed to facilitate the handling of the trucks.

Plank Road

For a distance of about three miles over the worst part of the route, with loose and shifting sand, a plank road

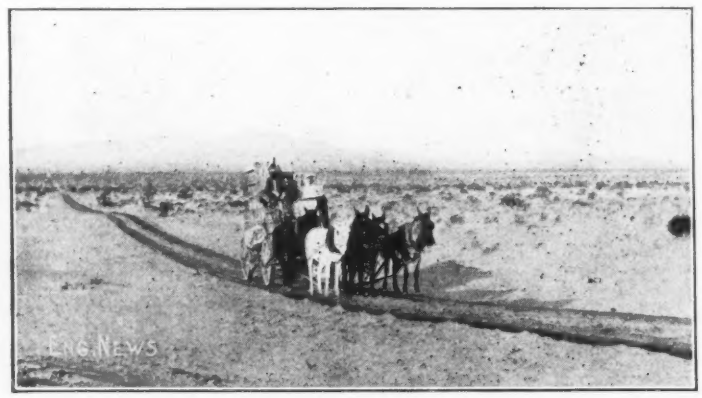


Fig. 2. Completed Plank Road, with Freighter's Team

Fig. 3. Bundles of Arrow-Weed for Foundation of Desert Road, Being Hauled to Place by a Motor Truck

has been built, with satisfactory results. Railway ties for the sand filling, the short blocks being concealed by the planks.

The roadbed was graded with four-horse fresno or buck scrapers, and after the planks had been laid the scrapers were used to fill sand between and over the ties. The sand is very fine and soon fills all voids under the ties and planks, so as to form a solid roadbed. When the planks had been laid they were given a coating of crude oil, to prevent warping under the intense summer heat and to give a better traction surface for the rubber tires. The cost of this construction was about $1500 per mile. Fig. 2 shows the finished road, with a freighter's team.

In this connection we may note the use of a plank roadway several years ago as a connection between a rail-

way and a quarry in an Eastern state. The dirt road was almost impassable in the spring, when it was desired to begin hauling stone, and the cost of building a hard road was prohibitive. A plank road was decided upon as a temporary expedient. A double line of planks was laid on old railway ties, and although the construction was very rough and crude (giving trouble by the loosening and tilting of the ends of the plank) the hauling was made with comparative ease while the daily capacity of the haulage was greatly increased.

Brush and Straw Roads

On other parts of the route to Blythe a roadbed was formed by placing a layer of brush of arrow-weed and covering this with sand. These weeds grow in the bottom lands to a height of 4 to 6 ft., and about ½ in. diameter. They were cut by hand with an ax and piled in bundles, which were hauled by a Saurer motor truck to the stretch of road to be improved. This is shown in Fig. 3. The bundles of weed were placed with their ends meeting in the center of the roadway, allowing the bushy and heaviest part to lie in the wheel tracks. The weeds were then covered thickly with straw. Finally a crew of Mexican and Indian laborers threw on a covering of sand and dirt to hold the straw and weeds in place. This formed a very solid base when compacted by passage of wagons and motor trucks.

This construction was used on a few miles of bad road that was some 40 miles from the railway. It would have been too expensive to haul in lumber for a plank road, and it was more economical to use the materials at hand. This kind of road construction cost about $80 per mile where weeds and straw were plentiful. We may note that straw is used as a covering for sandy roads in northern Wisconsin and elsewhere.

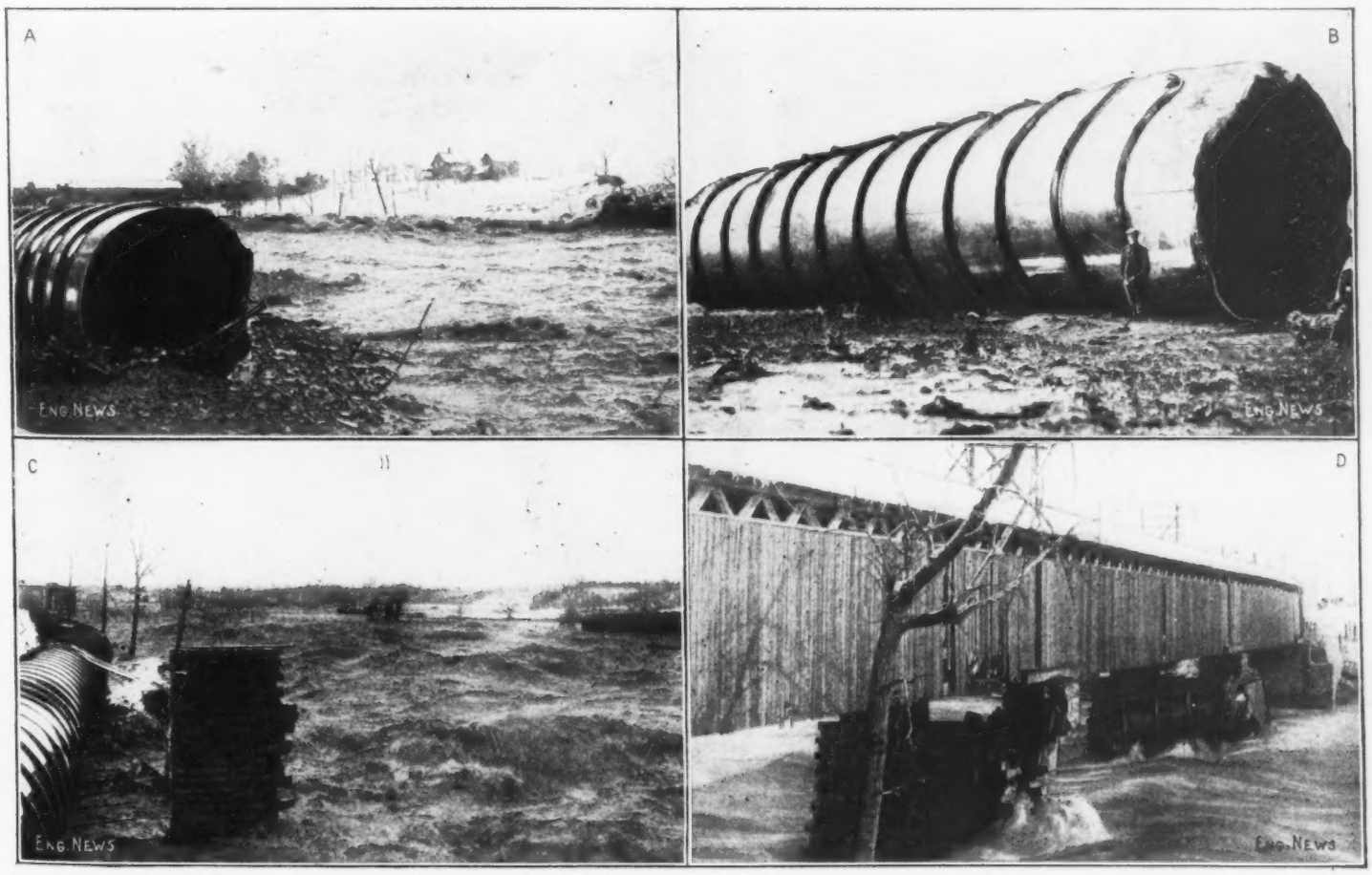
Freight Haulage

The distance between the town and the railway is about 50 miles. Freight teams required a week to make a round trip over the sandy road, and the charge for hauling was $20 per ton. There is now a regular service of Saurer trucks of 6½-tons capacity, each making a trip one way daily. The charge for hauling has been reduced to $7.50 per ton, with a much better service, and by agreement with the railway company, the latter makes through rates to Blythe (including the motor-truck service). For information we are indebted to W. H. Horrell, Phœnix, Ariz.

The End of the Balleville 14-Ft. Pipe

The 14-ft. penstock of the Balleville Hydroelectric Co., near Fremont, Ohio, whose collapse on Feb. 18 was noted in Engineering News of May 1, 1913, p. 909, was destroyed by the flood of Mar. 25, 1913. Herewith are four views showing the flood's work, sent us by L. H. Van Buskirk, Asst. Engr., Ohio State Board of Health.

The pipe was built last winter, and was finished in February, 1913. It was about 3000 ft. long. The pipe was 14 ft. in diameter, built of $\frac{5}{16}$-in. steel plates and stiffened at the ring joints, 7 ft. apart, with a 6x4-in. angle. It was supported by two lines of concrete pedestals, 6 ft. apart transversely and about 7 ft. apart longitudinally. Each 7-ft. length contained about 30 tons of water when full. The pipe collapsed at its first filling, the top buckling in and the sides bulging out.



The Balleville 14-Ft. Steel Pipe Destroyed by the Flood of Mar. 25, 1913.

An Engineer's Stage Journey through Arizona and Mexico in 1880

By C. L. Annan*

Thirty-two years ago New Mexico and Arizona were primitively wild. The Santa Fé Railroad had entered New Mexico on the north by a half-mile tunnel under Raton Pass and had penetrated to about the center of the Territory, following the old Santa Fé Trail south across the old Spanish land grants to Las Vegas. Thence winding westward in to the mountains, it steadily climbed the Pecos Valley to Glorieta Summit, dropping down to the other side and away to the Rio Grande. Construction trains were running down the river, and the grade was stretching rapidly to the south. West of the Rio Grande the country was terrorized by savages.

The ubiquitous Victorio, the most audacious Apache since the time of Cochise, dashed from point to point murdering, burning and mutilating, regardless of the cumbersome pursuit of the U. S. soldiery. If by chance, he was hard pressed, he slipped over the Mexican border and hid in the Sierra Madre Mountains awhile; but he might be expected to turn up at any time in the most improbable manner.

Things were beginning to take shape at Guaymas, the Pacific terminal of the Sonora Ry. to be, and a requisition for several engineers had been made on Chief Engineer Robinson of the Santa Fé. We started on the usual short notice. In due time we reached Albuquerque on the Rio Grande, where regular passenger service terminated and a hundred miles, more or less, must be undertaken on the construction trains of the extension southward.

By a lucky circumstance a parlor car for the accommodation of General Grant and his party, on their return from southern Mexico, was attached to the southbound material train with which we connected, so we occupied this coach as far as Bernalillo. Early in the afternoon the train pulled up at this pretty little station and the hungry travelers were not long in finding themselves at a well spread table in a near-by ranch house. As they strolled back toward the station the sky suddenly became overcast and heavy drops of rain began to fall. There was a general stampede for the shelter of the station house.

All at once I realized that I was elbowing General Grant, who stood just outside the door. The Ex-President was clad in a rusty Prince Albert and battered straw hat. He stood shoulder to shoulder with Indians, peons, vaqueros and what not, and with a closely burned cigar stump between the fingers of his right hand, unconcernedly watched the coming storm.

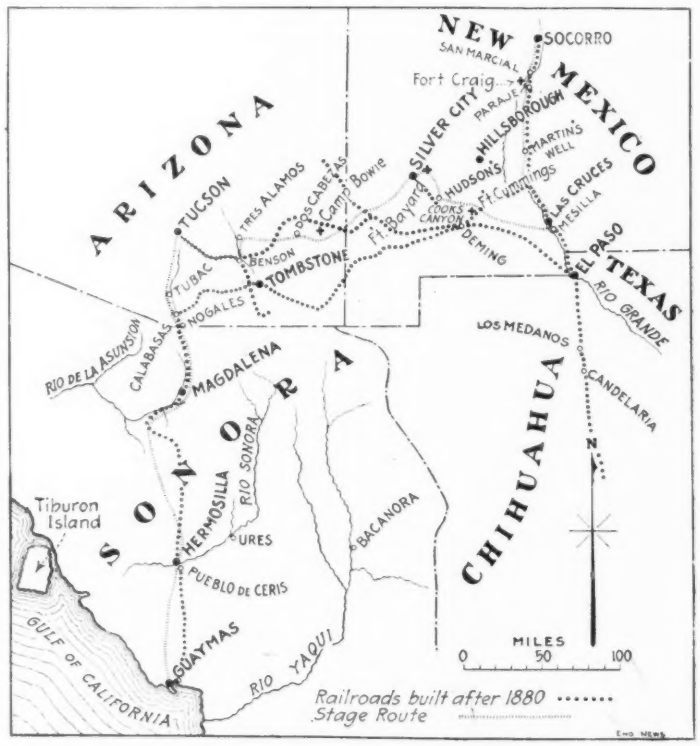
The rain ceased as suddenly as it came, which is a feature of the summer storms of this section. Directly after this copious shower, the patches of fallow ground in the vicinity were alive with myriads of minute toads, hopping in the sunlight.

A few miles farther south we reached the end of track in a waste of sand glittering in the burning sun. A short stage ride brought us to Socorro, a cluster of mud huts, where there was a large camp of engineers, our comrades of the last few years. Here we accepted warm greetings, and nonchalantly talked of old times and coming prospects. The evening reunion was a merry one and memorable to all who met again in after years.

At this village of Socorro we cut loose from the railroad and our stage journey began. Travel was heavy along the Rio Grande at that time and hotel accommodations at San Marcial, our first night's stop, were scanty. The late coming guests slept on the floor. A little after midnight a lively rattle of revolver shots roused the sleepers. Under such circumstances a bed on the floor had its advantages.

The next day the monotony of wheeling through sand was broken by the fording of the Rio Grande below Fort Craig. The road left the river at the ford and ran southward between two parallel mountain ranges for 85 miles. This waterless stretch, known as the Jornada del Muerto, was the dread of the old time freighters.

Finally emerging from the dry defile and striking the



Map Showing Route of Stage Journey through Arizona and Mexico in 1880

river once more, the sparse vegetation of the valley seemed luxuriant in comparison. Doña Ana, Las Cruces and Mesilla, sluggish Mexican settlements of considerable age, were passed.

Our stage-driver was Aleck Le Beau, a jolly old fellow, stalwart and breezy, who by his thrilling tales kept our hair standing on end the day following the passage of the Jornada. Old Aleck was in fine spirits as he drove his team into the shallow water of the ford at Mesilla and splashing across the broad bottom pulled up at the little house on the west side to say goodby to his wife and younger children. His was one of the most trying stages, that from the big river to Fort Cummings, across the sun-blackened desert with its patches of greasewood and amole.

"Yes," he said, "I've seen a little of life in the last 66 years. I didn't miss much of interest in the late Mexican war when I kept pretty close to the heels of General Scott. And I've lived among the Indians for years. I saw a good deal of the Sioux as a youngster.

*M. Am. Soc. C. E., 2129 Scudder St., St. Paul, Minn.

The Sioux are pretty bad medicine, but of all the rascally reds I've ever met, the Apaches are the most poisonous. I've met lots of 'em and done 'em favors and in the natural order of things they should bear me no ill will. They know me well enough and have never molested me but I don't trust 'em. I'll show you a place a few miles on where I got a big scare on my last trip. I've a sort of feeling that they'll get me yet.* I never carry a gun. You don't see 'em till they have the drop. Victorio is sure a bad one. We'll strike Magdalena Cañon about noon, and there you'll see how these Apache devils do their work."

When we came to the Magdalena cañon we saw the remains of a Mexican wagon train. The carcasses of the oxen lay where they had fallen, alternating with the charred remnants of the wagons. From the rocks on the hillside had come the deadly fire early one morning and the massacre had been complete. Le Beau's recitals served to while away the hours of dread that weighted the spirits of the "tenderfeet" in spite of themselves.

On the arrival of the stage at Fort Cummings late in the evening nothing of the whereabouts of the Apaches could be learned. At about 10:30 p.m. Sam *El Diablo,* having succeeded to Le Beau's responsibilities, whipped up a fresh relay of horses in a drizzling rain and pointed for the entrance to Cook's Cañon. The way was rugged but Sam, like old Aleck, was cheery and voluble although in rather a constrained way, being somewhat hampered by the weight of his reputation. Some forty-odd indictments, some of them for murder, were hanging over him in Grant County. To drive a stage from Fort Cummings to Silver City was a fit assignment for an outlaw. It was regarded as rather the most undesirable billet on the run, and Doubtful (Cook's) Cañon was the particular stretch which made it dismal.† The night hours wore on, rain came intermittently and the moon dodged the flying clouds. The road was steep and heavy.

"Gentlemen, I shall ask you to walk with me over this rise," and his two passengers alighted. "This is a bad stretch of a worse cañon," said he. "It's what you might call a cemetery. They say there's about thirty under that rock pile, but that was old Cochise's work. Just beyond here is a somewhat fresher planting. You've probably heard how that flying devil Victorio scooped the Lyon party here last month, five of them. Well, gentlemen, climb up again."

Sam desired to be considered a good fellow in spite of the indictments. He was obliging and quiet in manner, and seemed to enjoy recounting the doings of the stage men, as Le Beau and others had done before him.

The story of Font Wins was a favorite one. Deserted by his military escort at the first fire of the ambushed Apaches and brought to a standstill by the loss of a horse at the same volley, he had coolly spiked his team while the bullets were flying and had carried his passengers to safety.

Fort Bayard looked good in the morning after the dismal night in the cañon. Silver City was a noonday revelation. One could hardly realize that this brisk little settlement, with houses of burned brick and painted wood, was a possibility in that region after the eternal brown of the mud shacks and walls and the dusty dress of everything for hundreds of miles to the east.

We decided to stay over a day, get into touch with civilization, and allow our hair to relax.

Stage passengers are generally a sociable lot. The night coach west carried a comfortable quota of five. About midnight I threw aside my blanket and climbed to the box.

Toward morning I went below again for a little nap and found a fellow passenger, a Chinaman, stretched out on the front seat in full-length slumber. The other three, in postures more or less cramped, were measuredly breathing in different keys. I couldn't find my blanket but curled up in the chill night air and soon joined the chorus.

Day was breaking when the coach pulled up at the relay station. The passengers uncrimped and stretched themselves. The Chinaman rolled out of my blanket, yawned while he folded it, then passed it over. "This your blanket"? He must have been a cook. Chinese cooks were persons of distinction in the Southwest at that time.

"This must be the run of the man who defied the road agents about a month ago," said I to the new driver, as we bowled along among the cactus toward Apache Pass an hour or so later. "I'm the man," said he, "and this is my first trip since the accident." "It must have been fairly lively for you for a few minutes," "Yes, but it was soon over. I had only three passengers: a Mexican who was sitting where you are now with a Winchester in the hollow of his arm and a belt full of cartridges; a cranky old prospector, snoozing inside, and a fussy woman.

"You see the road falls a little for some distance. When we got abreast of that bunch of cactus two fellows stepped into the road, and covered me with their guns.

"The woman saw the move and fetched a squawk to raise the dead. The team shied, and taking the bits in their teeth made a dash down the road.

"This was a great surprise to the roadmen but they gathered themselves together for a parting shot. I felt a twinge in the leg and caught the Mexican by the belt just as he was toppling off the box. All Hell couldn't stop the broncos while the rifles rattled and the woman shrieked. I had my hands full as we flew along, dragging the reins with my right and holding the Mexican's belt with my left. The top of his head was shot clean off.

"When we slowed up, my boot was full of blood and I just naturally keeled over. Have been in the hospital ever since. See those two holes in my boot leg?. The bullet

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*The semi-monthly newspaper, published at Las Cruces, contained the following news item, a few weeks after this.

"One of the soldiers of the 16th Infantry stationed at the camp near Goodsite (16 miles east of Fort Cummings), from an eminence saw the hack coming up the road at about 4 p.m., and heard the shooting. He saw the hack turn back, and resolved to go to the place and see what was the matter. He found Le Beau, the driver, dead in the road at the place where the hack had turned, and following on he came to a point where he saw about ten Indians at the hack going through the mail. He returned and reported, and the troops then went out and got the bodies of Le Beau and Roberts and returned and sent a courier to General Buell at Cummings. Madden's body was found next morning a few yards from the road."

The account then goes on to state how the Apaches were pursued in the customary way and how, as usual, they escaped into Mexico.—C. L. A.

†In October, 1881, more than a year later, a Tucson newspaper, while reporting a recent Apache ambuscade in this deadly cleft, commented as follows:

"The road from Apache Pass to the east passes through this narrow, rocky and tortuous defile for a distance of three miles or more, and in past years the Indians have made use of its peculiar advantages in their method of warfare to massacre travelers. It is estimated that the bones of no less than 150 victims of Indian cruelty lie scattered throughout this cañon. The scene is pregnant with tales of horror and bloodshed."

that caught me struck that lamp guard, split, swerved and went into my leg in two pieces."

This sort of recital was becoming rather a matter of course, and familiarity with the participants was beginning to dull the edge of prospective horrors. Dread of the Apache was on the wane. The acute stage had passed, and a dull resignation succeeded.

Away the old "mud wagon" rumbled, over Apache Pass, by Fort Bowie, through a little oasis at Dos Cabezas, and on to Benson, without accident of any kind to break the dusty monotony.

A night ride of sixty miles by rail, a day's respite in that old Mexican oven, Tucson, and the travelers then turned southward toward Guaymas, our destination, which lies about three hundred miles due south of Tucson. The road winds up and down the parched broken valleys of dry waterways. The sparse grass, coarse and dry, the clumps of stunted, thorny shrubs, the occasional giant cactus, everything visible in fact, bathed in the impalpable clay dust, rising on the lightest breeze, takes its dreary tint, and the whole expanse of the broken desert is a monotone in dead brown.

The proprietor of the stage line was a Mexican, although the coach was the standard old Concord "mud-wagon"—normal capacity, nine inside passengers; initial speed of fresh relay, 15 miles per hour; average speed less than four miles, night and day; motive power, mules and broncos, the mules quite as bronco as the horses, for all run at large. They were herded over an extensive range, and if the corral was empty on the arrival of the stage there was no relay.

The regular trip between Tucson and Hermosillo, about 76 consecutive hours of ordinary duty fitted the Mexican drivers for all contingencies. It took two men to drive a team of six; the *cochero* in chief held the reins almost without respite. His assistant ran alongside the weary team with a short whip or threw stones at the leaders from the box.

No special arrangements were made for the convenience of passengers in the way of eating and sleeping along the route. An occasional solitary habitation of adobe or driven sticks passed during the three days and three nights of continuous travel offered pot luck for the passengers as opportunity might offer. What little sleep was to be had, was in, on, or under the coach.

We were now in the land of *tortillas* and *frijoles*. Late in the day the stage pulls up in front of a hut. A frowsy woman kneels in the open before a fire of *mesquite* roots patting a dough ball. A crock of thick porridge of well-cooked *frijoles* simmers on the hot stones. The dough ball, expanded to nearly the size of a barrel head, but as thin as a wafer, is laid on a hot earthen platter and quickly cooked. Behold the *tortilla*. With a small piece torn from the edge of the tough edible, the *frijoles* are scooped as in a spoon. And the spoon is incidentally eaten with its contents. A sufficient remnant may serve as a napkin at the conclusion of the meal.

Another word as to *el cochero*. The monotony of the pull on the lines may be varied by the fall of a wheel-horse in the mad rush of a fresh relay. The momentum may be checked in a hundred feet or so, and the tough animal may regain his feet for further service. The mending of the harness affords a little relaxation.

It is not at all surprising that after hours of strenuous attention the driver should succumb to drowsiness at times. Then the team may leave the road and stall the coach in a *mesquite* thicket. The sleeping passengers are aroused and politely requested to lend a hand at extricating the vehicle. The detached leaders become restive and make a dash for liberty, laying low their erstwhile persecutor of the short whip. Some hours are lost in their recovery, for the night is dark. *El cochero* does not repine.

Again a good road stretches away over the plain to the south, following a dry *arroyo* to the right. It is early morning, perhaps an hour before sunrise. He eases up on the reins. All about him are sleeping.

To relax is to sleep, the temptation is not to be resisted. When he comes to himself he is sprawling. The coach lies on its side in the bed of the *arroyo*. The startled inside passengers, much shaken, are trying to leave the wreck while the one who happened to have been sleeping on top lies insensible some fifteen feet away.

All this is apparently a matter of course to the Mexican jehu. He expresses neither surprise nor annoyance. He simply sets about putting things to rights. He directs the revival of the prostrate passenger and the righting of the coach, and is soon quietly on his way again.

Another day of heat and clouds of dust, another almost intolerable night and yet a few final hours in the broiling sun. The last relay is not forthcoming and most of the passengers walk the last few miles over the hot sands into Hermosillo for a bath and a square meal and a little sleep at full length. The luxurious cots are vacated at 3 a.m., and a dash is made at the last day's work under other auspices. Ninety miles in eighteen hours is the program.

The Guaymas welcome is a warm one. There is no cool evening breeze from the Gulf. A stifling heat prevails both day and night, month in and out. We fall in with some jolly companions, however, men earlier on the ground, some of them via the monthly steamer from San Francisco.

On completion of the road in 1882, the writer followed his chief to the other side of the Sierra Madre, but his traveling companion, Hugh T. Richards, remained, and a few years later became General Manager of the Sonora Ry.

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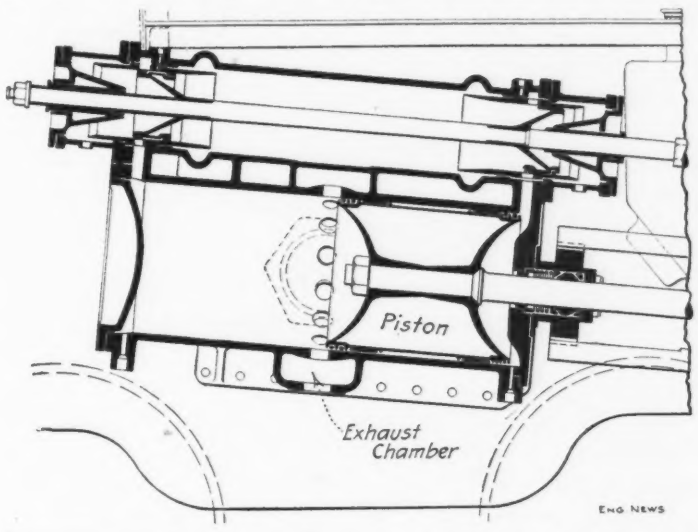
Data on Earthquakes are very limited. This is due partly to a lack of any ordered study of the subject in the past and partly to the reluctance of certain communities to admit earthquake damage. In order to give more complete data in the future, the Seismological Society of America, with headquarters at Leland Stanford, Jr., University in California, are endeavoring to collect all data possible, not only for the future study of earthquakes but for the use of engineers who may wish information regarding the possible seismological conditions in any particular locality of the country.

In an article in the "Bulletin of the Seismological Society of America" for March, 1913, J. C. Branner, now President of Leland Stanford University, states that the society has received several requests from different engineers for information about the frequency and character of earthquakes in some particular district, and that it has always had to admit ignorance of the subject. He requests all who can to make what observations are possible regarding earthquake shocks and to send them with full data, whether such data be scientific or not, to the Seismological Society, so that they may start toward the building up of statistics on the subject. He further states that while this would seem to be the duty of some federal scientific bureau, so far it has not been possible to interest any particular bureau in the subject sufficiently to guarantee any accurate or complete record on the subject.

A Locomotive with the Stumpf Direct-Flow System of Steam Distribution

A locomotive with the Stumpf system of cylinders and valves for direct flow of steam has been built for the Northeastern Ry., England, and is an interesting novelty in locomotive design, although a few locomotives of this type are in use in other European countries. In the ordinary locomotive, steam entering at either end of the cylinder follows the piston in its stroke and then (as the piston makes its return strokes) the steam reverses its motion, the expanded and partly cooled steam being forced out at the same end of the cylinder and through the port which is to be used by the next inflow of hot steam. In the Stumpf system, the exhaust ports are at the middle of the cylinder so that this cooling effect is avoided. This arrangement necessitates the use of a long cylinder and a long drum-shaped piston, as shown in the



Locomotive Cylinder, Piston and Valve for Direct-Flow Steam Distribution (Stumpf System); Northeastern Ry., England

accompanying cut. This system is claimed to be a satisfactory substitute for superheating, and it is further claimed that its steam consumption is as low as that of a compound engine. The Northern Ry. locomotive, however, is equipped with a superheater.

In the Northeastern Ry. engine the cylinders are 20 in. diameter and 4 ft. 8 in. long, with a stroke of 26 in. The exhaust ports are a series of holes drilled round the cylinder walls and leading into an annular exhaust chamber. The piston fills approximately half of the cylinder volume. In fact, at the end of each stroke one or other of its edges is just clearing the ring of exhaust ports and allowing exhaust to take place. In this way each half of the cylinder volume has to deal with the steam from only one inlet port, and as the total area of the exhaust port is large the period of exhaust extends from a short time before the end of the stroke until a short time after. The bulk of the one stroke is thus occupied with the admission and expansion, and the bulk of the other with the compression of the steam. In general, the period of exhaust covers 10% of the stroke each way, so that admission and expansion occupy 90% of the stroke in one direction and compression 90% of the stroke in the other direction.

The pistons are hollow castings with spring rings at each end. The admission of steam is controlled by piston valves operated by Walschaerts valve gear. The valves have inside admission; their maximum travel is 6½ in. and their exhaust lap 1¾ in. When the engine is running in full gear the valve ports provide an auxiliary exhaust; but when the engine is notched up, this auxiliary exhaust is closed and all the steam escapes by way of the central ring of ports.

The engine is of the 4:6:0 type, for fast freight service, with a total weight of 72 tons (54 tons on drivers). It was built to the designs of Mr. Raven, Chief Mechanical Engineer of the Northeastern Ry. Our information concerning it is taken from an article in *The Engineer*, of London.

Rules for the Protection of Electric-Service Employees; an Order of the New York Public Service Commission (First District)

Hearings were recently completed on the question of regulations to be prescribed as to all public-service corporations within the jurisdiction of the Public Service Commission for the First District of New York State (New York City) for the protection of employees from injury by high-tension electrical equipment or other dangerous conditions. As a result the following requirements have been fixed to apply on and after July 1, 1913:

(1) All high-tension switch compartments shall, so far as their construction will permit, be so inclosed as to make it impossible, except when necessarily opening the compartments, for employees to come in contact with electrically charged parts either from or above the floor level.

(2) All exposed high-tension cables in power or substations shall be inclosed by screens or otherwise protected.

(3) There shall be posted, in conspicuous places in all the power houses and substations, diagrams describing and showing the relative location of wires and cables (except lighting and signal wires) and the switches, etc., controlling them and all such wires, cables and connections shall be so tagged and numbered that they may be readily identified.

(4) All machines for the generation of current or connected with such generation shall be so protected by railings and gratings as to safeguard operators and others from coming in contact with moving or electrically charged parts.

(5) There shall be at least two operators on duty in rotary-transformer stations delivering current at 500 volts or higher when the same are in operation.

(6) All water-level glasses or gage-glasses on tanks, standpipes, or other storage receivers under pressure, shall be protected by screens to prevent injury in case of a bursting glass.

(7) Test cocks on water columns shall be fitted with extension rods or chains so as to be operative from the boiler-room floor level.

(8) All stop valves on steam boilers shall be of the automatic self-closing type.

(9) Outlets of all safety valves shall be vertical.

(10) All furnace doors on hand-fired boilers shall be fitted with latches or catches to prevent them from being blown open.

(11) All moving parts of stokers shall be so protected, wherever possible, as to prevent accidental contact with such moving parts.

(12) All large main cutout stop valves shall be provided with means whereby the same may be closed from the boiler or engine-room floor or other remote point.

(13) All large steam units shall be fitted with automatic self-closing valves.

(14) All high-speed engines shall be fitted with automatic safety stops.

(15) Elevator wells shall be properly and substantially inclosed, secured or guarded and shall be provided with proper traps and automatic doors in or at all elevator ways so as to furnish substantial covering when closed and to

open and close by action of the elevator when ascending or descending.

(16) All openings in floors shall be roped off or protected by railings when left unguarded, and, in addition, a red light shall be hung in the immediate vicinity when the location is unlighted or poorly lighted.

(17) All stairways shall be provided with safety treads, kept free from oil and water and be properly protected with hand-rails.

(18) Shafting running along or passing through floors shall be housed or screened or otherwise properly guarded.

(19) All belting shall be inclosed or otherwise protected wherever accidental contact is possible.

(20) Gear-case covers completely inclosing the gears shall be fitted to all machine tools and be kept in place while such tools are being used.

(21) Set screws and keys in exposed positions on moving machinery and shafting shall be countersunk or otherwise properly protected.

(22) Buzz saws and band saws shall be protected so as to prevent accidental contact with saw blades.

(23) Grinding and emery wheels shall be properly guarded and equipped with hoods and exhaust pipes to draw off finely powdered material.

(24) Guard glasses shall be provided for employees and used by them when engaged upon any work causing chips or fragments to fly, and wire screens of a portable or permanent type shall be set up on work benches or around employees engaged in chipping.

(25) A sufficient number of pails of clean, dry sand must be kept in all power stations, substations, auxiliary and switching stations.

(26) Power stations, substations, auxiliary and switching stations shall be provided with a sufficient number of chemical fire extinguishers of such a type that the contents cannot act as an electrical conductor. No other extinguishers shall be kept for use unless conspicuously labeled that they are not to be used until current has been shut off.

(27) All power stations, substations, auxiliary and switching stations and shops shall be provided with a first-aid or emergency kit.

(28) Provision shall be made whereby pulmotors will be available in case of accidents.

And it is further ordered that on or before June 1, 1913, said companies and said receivers adopt, promulgate and thereafter rigidly enforce rules and regulations to govern their employees in the handling of high-tension apparatus and in the handling of steam and mechanical apparatus in power stations, substations and shops.

NOTES FROM THE ENGINEERING SCHOOLS

UNIVERSITY OF ILLINOIS—The land grant made to this institution by the Federal government in 1862 requires military instruction to be given to all students, and an army officer is detailed to supervise the work. The old armory provides for a regiment of about 500 cadets, but in 1912 the cadet regiment of the University numbered 1525. The legislature of the state of Illinois has made an appropriation for a new armory, and this is now under construction. It will be 420x276 ft., with a drill hall having a clean floor space 394x200 ft., flanked on the longer sides by the company rooms, and having on these sides galleries, which will accommodate 3000 people. Above the galleries are two rifle ranges. The drill hall is spanned by steel arch trusses of the three-hinged type, spaced 26 ft. apart. In this great hall the entire regiment can be drilled. It will be used also as an assembly hall for commencement ceremonies, conventions, and other large gatherings.

UNIVERSITY OF CALIFORNIA—Among the graduate scholarships and scholarships announced by the University of California for the year 1913 and 1914 the following are noted as of interest to engineers:

(1) Ten University scholarships, yielding $400 each, available in any of the colleges of letters, sciences and engineering. (2) Two Flood scholarships in economics, yielding $400 each. (3) Two John W. Mackay, Jr., scholarships in electrical engineering, yielding $600 each. (4) Three Lick Observatory scholarships in astronomy, yielding $600 each. (5) One or two scholarships in physics under the Whiting fund, yielding $600 each. (6) One James M. Goewey scholarship in natural science, yielding $250. (7) One research scholarship in problems of city growth, yielding $1000.

Awards are made not upon basis of financial need, but solely for merit in scholarship and ability for research work.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—A four-year course has been established in industrial physics as the outcome of demand felt for men trained for the investigation of physical problems that arise in the industries. The studies in physics embraced in this course require a less extended pursuit of pure and applied mathematics and more attention to applied physics in the lectures and laboratories. Applied optics, and heat and electrical measurements are greatly extended. Much time is devoted to the theory and practice of chemistry, to mechanical and electrical engineering subjects, electrochemistry, metallography, etc.; a large amount of equipment has been made available for precise measurements.

The aim will be to develop a man possessing such a knowledge of physical investigation and methods of attacking physical problems that he may deal intelligently with any questions of this nature that may arise in connection with various processes of the arts. The Institute is recommending this course for men only of unusual ability and especially those with manifest initiative. A full four-year course will be developed and those who desire to follow it must pursue the whole course for the scheduled time.

Liquefied Chlorine Gas for Water Disinfection is now being used in several cities. It was first tested experimentally by the manufacturers of liquid chlorine at their Niagara Falls plant and later in the Mount Prospect Laboratory of the Department of Water Supply, New York City, by D. D. Jackson, chemist of the department, early in 1912. In July, 1912, it was used at the Belmont filter plant of the Philadelphia water-works. In November, 1912, it was put in use at Wilmington, Del., and at the Western New York Water Co.'s plant at Niagara Falls, N. Y., and since then it has been adopted at Somersworth, N. H. The chlorine gas is one of the products of the electrolytic decomposition of brine, caustic soda being the other. The gas is purified, liquefied by compression and refrigeration, and is placed in 8x60-in. steel cylinders for shipment. Each cylinder weigh about 85 lb. and contains from 100 to 110 lb. of liquid chlorine, under pressures ranging from 54 lb. at freezing to 125 lb. at 85° F. In utilizing the liquid chlorine it is discharged at the desired rate through control apparatus into an absorption tower where it combines with a spray of water which carries it into the water-supply for which treatment is desired. Liquid chlorine is made by the Electro-Bleaching Gas Co., of 25 Madison Ave., New York City, which has also developed a control apparatus. John A. Kienle, until recently chief engineer of the Water Department of Wilmington, Del., and under whose direction liquid chlorine was introduced in Wilmington, is now sanitary engineer of the company just named. The company has been engaged for the past seven years in manufacturing liquid chlorine for bleaching purposes and the chemical trade generally. It states that experience has demonstrated that for both bleaching purposes and for water-treatment chlorine in liquid form is much more efficient, unit for unit, than in the form of bleaching powder, or hypochlorite of lime, besides requiring less elaborate and expensive equipment for the application of the chemical and practically eliminating labor and power costs of operation.

EDITORIALS

Filter Killing in New York

The killing of the Croton water-filtration project by the Board of Estimate of New York City on May 22, after a four months' hold-up of the award of the contract for a 320,000,000-gal. mechanical filtration plant, sacrificed one more carefully wrought engineering project to the great game of American municipal politics. This particular killing comes in one of those pre-election fits of economy which so often follow the incurring of huge debts for municipal improvements made necessary by the rapid growth of American cities. The alleged ground for the killing is that filtration is not necessary. As we showed last week, it is late in the day to raise that point.

Aside from the need for filtration two serious aspects of this filter killing are: (1) The plans and specifications on which bids were based have cost the city a round $100,000 or so; (2) at the solicitation of the great city of New York numerous contractors throughout the country spent time and money to prepare and submit bids for the proposed filters, which a majority of the Board of Estimate finally decided were not needed at all. We suggest that hereafter contractors bidding on New York City work insist on the city putting up a certified check as a guarantee that the responsible authorities will not change their minds as to the need of the improvement on which bids are asked.

Finally, there is a human element involved in this unfortunate incident which deserves thought. Twenty to thirty engineers and draftsmen, including a number of the most experienced filtration engineers of the country, have wrought two of the best years of their lives into these plans and on their ultimate carrying out have based (especially the younger men) high hopes for their professional future. To these men it is a bitter experience to have their work stop with the blueprint stage. But it is the common lot of the engineer to see his best efforts sacrificed in the political game. As an engineer has just written to us in commenting on this matter: "Verily, the ways of politicians are beyond understanding"!

The Philosophy of the Uni Flow Steam Engine

A brief description is given elsewhere in this issue of a new locomotive recently put in service on the Northeastern Railway of England, which has cylinders arranged for the Stumpf system of steam distribution. As steam engines of this type for various purposes are receiving much attention just now and their construction has been taken up by several American engine builders, an elementary explanation of the principles on which this type of engine operates, may be of interest to those who do not closely follow this branch of engineering work.

In the first place, to thresh over old straw, it is well to get clearly in mind just what is meant by the statement of authorities on steam engineering that one of the chief sources of loss in the development of power from steam is the heat loss inside the cylinder, due to the varying temperatures of the steam at different points of the stroke. We recall a statement published some years ago which made this heat loss far easier for the average engineer to comprehend than any abstract or mathematical statement possibly could. The statement was substantially as follows:

In the cylinder of an ordinary locomotive, using steam at 200 lb. boiler pressure, the temperature of the steam when it enters the cylinder will be about 388° F. When the steam inlet valve closes and expansion begins, the temperature of the steam runs rapidly down, and when the exhaust port opens, it instantly falls to 212 deg. During the whole of the exhaust stroke, the cylinder, the piston surface and the ports through which the steam flows, are exposed to this temperature of 212°. The difference between the temperature of the live steam as it enters the cylinder and the exhaust steam as it leaves, is 176°. This difference of temperature is as great as the difference between the hottest summer day in the Torrid Zone and the lowest temperature recorded in Arctic explorations.

Drop a piece of ice into boiling water, and note how rapidly it is cooled. The difference in temperature between the ice and the boiling water is substantially the same as that between the steam as it enters the locomotive cylinder and the same steam when it flows out of the exhaust.

The advantage of a compound or triple or quadruple expansion engine over the simple engine is that this temperature range is distributed through several cylinders, so that the flow of heat into the cylinder wall from the hot steam, and back again into the exhaust steam as it passes out, is very much less. This also explains, to a large degree, the superior economy of the four-valve engine over the plain slide-valve. By merely providing that the exhaust steam shall pass out through ports which are entirely separate from those through which the live steam enters, we make a large gain in economy.

In the Stumpf "Uni-Flow" engine, the exhaust ports are entirely separate from the inlet ports, and further, they are placed at the middle of the cylinder, while the inlet ports are at the ends. Thus the exhaust steam does not have to flow back to the end of the cylinder in order to escape.

In Europe, where fuel economy in locomotives receives far greater attention than in this country, locomotives have been built at various times equipped with separate admission and exhaust valves. The complications required in the valve motion, to secure variable cutoff and compression and reversing, have prevented such locomotives from ever coming into extensive use. By adapting the Stumpf system to locomotives, however, it would seem to be possible to make a valve motion which would not

be much more complicated than the valve motion now in use for driving piston and slide valves. The high compression, which is one feature of the Stumpf system, has its advantages for high-speed locomotive service, and if it is possible to keep the weight of the long piston down within reasonable limits, the new system may open a practicable means for effecting a material increase in locomotive fuel economy.

Publicity Work by Engineering Societies

An interesting letter appears in the correspondence columns of this issue regarding the results of the systematic efforts of the Cleveland Engineering Society to gain publicity for things of an engineering nature through the medium of the daily newspaper. Similar work is done by the Brooklyn Engineers' Club and probably by other local engineering societies. There is an opportunity for much good to be done the engineering profession by thus gaining a more appreciative consideration of the problems and achievements of engineers, and by giving engineers a larger share in the discussion of civic affairs.

If well done coöperation between the newspapers and the local engineering society will tend to increase the usefulness of both; but there is danger in indiscriminate enthusiasm for publicity at any cost, which an organization that wishes to maintain its standing as a *scientific* and *professional* society would do well to curb. Publicity, so called, may imperceptibly degenerate into mere notoriety. A good example of it is the kind of publicity that has been gained through magnificent schemes for changing the climate of the Northern Hemisphere and preventing floods in the Mississippi Valley.

Mere popularizing of engineering may not prove an unqualified blessing. Many able physicians and lawyers very decidedly disapprove of popularizing their professions; for there are people to whom a little knowledge is a dangerous possession. Reading articles in newspapers about home-made medicines and cure-alls seldom makes an average man competent as his own family doctor; and popular articles on law and legal advice never yet fitted a man to be his own lawyer. Since the theory and practice of engineering and the language of engineering are not less technical than are those of law and medicine, it may seriously be questioned how far the work of popularizing engineering ought to be carried. May not attempts to state complex engineering facts in terms of glittering generalities to attract the public eye ultimately react on the dignity of the engineering profession on which so much stress has been laid?

Particular emphasis should, therefore, be placed on the statement in Mr. Drayer's letter that articles are prepared by Publicity Committee of the Cleveland Engineering Society for the newspapers and are written in a *dignified manner*—more than that there should be no sacrifice of accuracy. The Cleveland society is to be congratulated that the articles inclosed with Mr. Drayer's letter are so prepared, and yet so written as to interest the public. If such articles are not prepared by members of an engineering society they should at least be passed upon by a committee before they are published, or many chance remarks may be picked up and featured in the headlines of a sensational newspaper, which will not reflect any credit on the society from thinking men.

Moreover, publicity, like spirituous liquors, is intoxicating. Many a professional man has found out to his chagrin that self-sought publicity may ultimately prove anything but desirable. The same may prove equally true of an engineering society. The members should not lose sight of the fact that they are and wish to be considered professional men, and that there is a gap between them and the general public which must be maintained if they wish to finally achieve the prestige which all this publicity work is intended to give. It may be much more necessary for the public to have a proper respect for the learnedness and the dignity of the engineering profession than that engineers should immediately come to their own in the share of glory to be distributed.

A Needed Reform in the Conduct of Engineering Competitions

In ENGINEERING NEWS of Jan. 30, 1913, and in each of the succeeding three issues, as well as in some other engineering and daily newspapers, there appeared the following advertisement:

Bridge and Viaduct Approaches

Richmond, Va., January 27th, 1913.

Competitive plans, specifications and approximate cost for the erection of a reinforced-concrete bridge and viaduct approaches on the site of the present Free Bridge over James River, from 9th and Byrd Streets to 7th and Semmes Streets will be received by the Administrative Board until April 15th, 1913, at 12:00 o'clock Noon.

For the first or accepted design a premium of $1,500.00 is offered.

For the second best design a premium of $500.00 is offered.

Information of location and profile and present grades of streets will be furnished by the City Engineer.

The Administrative Board reserves the right to reject any and all plans submitted.

ROBERT WHITTET, JR.,
Chairman, Administrative Board.

To such engineers as were sufficiently attracted by this notice to ask for further information there was sent a blueprint showing the location, plan and profiles of the proposed bridge and the following program of the competition:

OFFICE OF CITY ENGINEER.
Richmond, Va., March 4, 1913.

REQUIREMENTS OF THE ADMINISTRATIVE BOARD GOVERNING THOSE FILING DESIGNS AND PLANS FOR THE ERECTION OF A REINFORCED-CONCRETE BRIDGE OVER JAMES RIVER ON THE PRESENT FREE BRIDGE SITE AND ALSO REINFORCED-CONCRETE APPROACHES.

1. Plans, designs and specifications; also detail drawings sufficient to clearly explain and define the designs, and an approximate estimate of the cost of the structures must be submitted to the Administrative Board not later than April 15th, 1913. All designs submitted must be in black and white.

2. The bridge and approaches to be designed for reinforced concrete of such construction as to provide and care for safely the heaviest traffic loads for municipal service and for street cars at an estimated weight of 60 tons each. The bridge and viaduct to be not less than sixty (60) feet wide and the roadway to be not less than forty-four (44) feet (exclusive of sidewalks and including railing.) The bridge proper is to extend from shore to shore of James River and the viaducts to the termini to be as shown on the blue print furnished by the City Engineer. The character of the material to be used for paving roadbed and sidewalks is to be shown and also the kind and style of curbing and a detail of the railing. Poles for carrying wires for a double track electric railway and to be used also for the lighting of the bridge must also be shown and described. Space provision in the roadway or sidewalk must be shown for the installation of a

12 in. bell and spigot water main; a 20 in. bell and spigot gas main; and for a 4.5 sq.ft. area space for conduit ducts on each side of the bridge for high and low power wires. Provision must also be made for the lamps for lighting the bridge.

3. The bridge must be of such design as to vent readily the river flow of the highest recorded freshets. The plan showing the location and the profile showing approximately the surface of the rock bottom of James River; the present grades of the old bridge and streets; and a few sections showing the existing grades of said streets and the highest freshet water will be furnished by the City Engineer. All persons desiring to submit a design will be furnished with these conditions and blue prints, but are requested to return same to the City Engineer if they decide not to submit a design.

The awards to be paid for the accepted designs will be $1,500 for the first and $500 for the second best design.

The Administrative Board reserves the right to reject any and all designs or plans which may be submitted.

CHAS. E. BOLLING,
City Engineer.

As a result of the advertisement, 27 different designs were submitted to the Administrative Board of the City of Richmond by as many engineers or firms of engineers from all parts of the country, their headquarters running from Kansas City and Chicago in the West to Boston and New York in the East, and Nashville in the South, with a fair number of local competitors. In this list there were names of some of the best known concrete bridge designers in the United States, as well as many as yet unknown to fame or fortune. The plans submitted varied in quantity and nature from a full set of working drawings, accompanied by expensive architectural renderings of the proposed structure, to simple blueprints outlining only the salient features of the design.

The above notices were the only official ones which were publicly given to interested parties. Certain of the competitors, however, had learned (by personal inquiry and not from any general announcement) that the Board would consent to hear the plea of any competitor who might choose to present orally the virtues of his design. Such engineers to the number of nearly a dozen appeared before the Board and its advisor, a member of a local architectural and engineering firm, and for three days the Board heard their representations, apparently allowing each one as long a time as he considered necessary. After this rather laborious proceeding, the interest of the Board in the bridge matter was temporarily exhausted and no further consideration was given the matter for some time. On May 9 a representative of ENGINEERING NEWS was shown a great number of the designs submitted still safely reposing inside of the mail coverings in which they were sent. At that time it was stated by those in authority that the Board would probably finish up the inspection in two or three weeks, but no assurance was given of that fact. At any rate, at the time of this writing (May 27) the award has not been made.

Such in brief is the outline of one of the most flagrant examples of how not to conduct an engineering competition that has come to our notice. Because the injustice done by the Richmond authorities to the competing engineers is no less an injustice to the engineering profession in general, it seems to us that a full account of the case should be brought to the attention of the profession with a view to bringing about some reform in this matter of engineering competitions.

Most engineers believe that no useful purpose is served by holding competitions for engineering design. They believe that the multifold details that make up a completed structure cannot be explicitly set forth in any preliminary design, nor its suitability or superiority predicated from the engineer's first drawings. Notwithstanding this attitude by the profession at large, the fact remains that competitions for designs of engineering structures are occasionally held by authorities, generally by political bodies honestly seeking for the best design, to whom the professional objection seems selfish in the extreme.

Quite ignorant as to how to find engineers competent to prepare the plans for the structure desired, they assume that the city or county or state has a perfect right to endeavor to enlist the best available talent in a competition. Since such competitions are, therefore, unavoidable in certain cases, it should be the duty of the representative bodies of the profession to formulate a code of rules which could govern such competitions and to which members of the profession in good standing would conform.

Some time ago this was realized by those working in the architectural field and the American Institute of Architects formulated its well known code for the conduct of competitions. This code has been generally followed in large architectural competitions and has proved satisfactory. Whether its provisions would be suitable for engineering competition would require investigation, but the code could be profitably read by any committee of an engineering society which contemplates the drawing up of a similar code for engineers.

Any competition to select the proper design for an engineering structure should have certain strict fundamentals. Most of these fundamentals are absent in the Richmond competition. In the first place there should be a complete definition of the requirements of both the competition and the design, so that the competitors may start on a fair and even basis and so, also, that they may more readily meet the minds of the body holding the competition as to the structure desired. The program in the case of a bridge competition, for instance, should give full details as to how the competition is to be carried on. It should precisely stipulate the kind and extent of the drawings, should prescribe the date of the opening of the drawings and the latest date for the decision, should state whether the competitors are to be allowed to appear before the examining board and preferably should state whether or not the designer selected for first prize is to be given charge of the construction of the bridge either as supervising or as consulting engineer. It can readily be seen how few of these requirements are satisfied in the Richmond case.

The requirements of the design itself should be no less explicitly stated. First and foremost, the nature of the structure and its maximum allowable cost should be given. Any engineer knows that a bridge across a river at a given site may have a very wide range of cost. A competition which does not specify the nature and cost of the structure required will bring forth a variety of designs, one of which may meet the approval of the examining body, but it is not fair to those who do not happen to have the same mind in the matter as that body to leave those requirements as a matter of personal taste. Merely to state, as the Richmond authorities did, that a reinforced-concrete structure to carry certain loads is required is far from sufficient.

The definition of the requirements of both compe-

tition and design being satisfied, the next most important matter is that a competent examining body be provided. That body should preferably be a board of engineers who will act as a jury to report to the political body which has the matter in charge. If this is not feasible at least there should be a competent engineering advisor who will sit with that political body and whose advice in matters purely technical will be followed. Just why a body of elected officials, none of whom probably has any engineering or architectural experience, should be supposed to be able to decide which one of 27 designs is the proper one for some river crossing is beyond comprehension. In the Richmond case there was an engineer advisor, and one member of the Board who happened to be an engineer, but the deliberations of the Board being not open to public notice we have no way of knowing how far the advice of these gentlemen governed the final selection. At any rate, the engineer who acted as advisor is a young man of somewhat limited experience whose previous services would hardly qualify him as the final authority in the acceptance of a design of a bridge which is estimated to cost between $500,000 and $700,000. On account of certain local political conditions the city engineer had no connection with the competition beyond the preparation of the program given above.

Finally, any open competition for the design of an engineering structure should be conducted anonymously. As long as one competitor or a group of competitors are allowed to appear before the examining body to argue the merit of their own designs, there will always be a possibility of undue influence being used, to say nothing of the unfairness to other competitors who cannot or do not appear before that body. In the Richmond case there is no suspicion whatever thrown upon the integrity of the members of the Board or of any of the engineers who presented themselves to defend their design. There are occasions, however, when ignorance can do more harm than an evil intent.

These severe criticisms of the method of conducting the Richmond competition are made with full appreciation of the position of the Richmond Administrative Board. It deserves to be said in its behalf that there is no particular reason why that Board should not have done as it did inasmuch as there is no recognized professional method of carrying on such a competition.

It may be added also that the political conditions in Richmond are such that the Administrative Board is somewhat reluctant to proceed with the construction or even with the award of the prizes for the design of the bridge. In fact, it seems hardly likely, at present, that the bridge will be constructed for some time, which, incidentally, should have been noted in the invitation to competitors.

Notwithstanding the conditions of the competition, nearly thirty engineers submitted drawings and about a dozen of them spent the time and money to go to Richmond and explain their designs. The two engineers who receive the first and the second prizes will probably just about get back what they have spent on the work. All other engineers will have spent their time and money in vain, and what is even worse, will have labored under conditions which made a fair and intelligent award very doubtful. It is safe to say that the total amount expended by engineers on competition at Richmond will amount to $20,000. Of this amount the city of Richmond pays $2000 and the remaining $18,000 represents loss by engineers, sheer economic waste. Surely such competitions of engineering designs are a disastrous burden upon the profession.

We sincerely trust that some such organization as the American Society of Civil Engineers will look into this matter and appoint a competent committee to draw up some code to govern engineering competitions that will make them less disastrous to the participants.

In the absence of such a recognized code established by the profession itself, and recognized by it as authoratative, there is nothing to hinder any city or any corporation following the example of Richmond and by the offer of a few small prizes, putting engineers under a heavy burden of expense.

LETTERS TO THE EDITOR

Algae in the Water-Works Reservoir at Quincy, Ill., and Elsewhere

Sir:—I was much interested in the article with the foregoing title published in your issue of Apr. 24, 1913.

The organisms are described as "a mossy growth"—a growth about the size of a pin's head, "nearly globular and light green in color" (this is probably Volvox)—"a thin layer of green moss from which bubbles were rising to the surface"—"small patches of floating vegetable matter."

I wonder how engineers, confronted for years with these troublesome visitors, can be satisfied with such scanty knowledge and never feel the curiosity to know about these organisms. "As we do not have the necessary equipment for making the microscopic examination, no attempt was made to identify any organisms," says the engineer. A good pocket-lens and Whipple's book in the hands of an intelligent—and willing—foreman would do much. These can be had at small cost and even the willingness can be secured. And then, there is undoubtedly in Quincy, Ill., or neighborhood, a microscope and a man; the engineer himself must not necessarily be a trained naturalist, besides his many other qualifications; but he could apply to competent quarters for information. As to the practical side of such knowledge, the quantity of copper salt is to be regulated by the nature of the organism.

Ad. Kemna,
Antwerp Water-Works Co.
6 Rue Montebello, Antwerp, Belgium,
May 4, 1913.

The Early Agitation for a National Department of Public Works

Sir—In ENGINEERING NEWS of Apr. 24, just at hand, is an account of the proceedings of the Annual Convention of the National Drainage Congress at St. Louis. You give an extract of an address by Mr. Isham Randolph, in which he advocates a Federal Department of Public Works.

It may interest your readers to know that this same proposition was not only made some years ago during President Cleveland's administration, but was personally presented to him and to Congress by a group of engineers, who then realized fully the importance of what we called "A Rational Policy of Public Works."

We were unable to carry through what was then proposed, but two of our reforms were adopted—with no recognition of our efforts, however. One was the continuing contract system which supplied work once begun with the necessary funds for their completion. This matter I personally helped to get up with Senator Blanchard, of Louisiana, and he was in full accord with the idea and it was largely through his work and that of Mr. Clifton R. Breckenridge, Member of the House, that the matter was carried through. The other subject was the dividing of the whole country into grand divisions, each in charge of a Division Engineer. This has been done by the existing authorities.

The pamphlet and the bill presented to Congress at that time will show what it was attempted to accomplish. Mr. Lyman E. Cooley was the moving spirit in this project and the editor of the literary features and if the Department of Public Works should ever be created, he should have the credit of having originated the idea and urged it in season and out of season. Like many other reforms, we were not only abreast, but ahead of the times; but "all things come to him who waits" and *works*.

E. L. CORTHELL.

Berne, Switzerland, May 7, 1913.

Publicity Work of the Cleveland Engineering Society

Sir—Early in the fall of 1912 the Cleveland Engineering Society created a Publicity Committee to do certain things enumerated in a letter by the writer, published in ENGINEERING NEWS of Sept. 5, 1912. Since the efforts of almost a year can now be summed up, the results of the committee's work may be of interest to a goodly number of engineers desiring to improve the standing of the profession and to do civic good.

The first step was to obtain from the leading daily newspapers of the city their viewpoint by submitting "stories" of what transpired in the local engineering society written in a dignified manner and so as to be understood by the general public. At once it was evident that we could expect hearty coöperation from the newspapers. They soon came to recognize the value and authority of this service and welcomed contributions.

To date there have appeared in the local newspapers 695 in. or about 33 columns of engineering matter. This includes advance notices of meetings containing a picture of the speaker and descriptive matter telling how the subject would be treated; abstracts, sometimes with pictures, of the papers presented before the society; write-ups of inspection trips by the society to industries in and around Cleveland and two articles of an inspirational nature by leading engineers for the guidance of those about to choose a profession.

To illustrate the nature of the work there was a ¾-page article in the magazine sections of the Cleveland *Plain Dealer*, Apr. 13 and 20, on "The Work of the Engineer," by A. J. Himes, President of the Cleveland Engineering Society, and an article in the same newspaper on "Mechanical Engineering," by Worcester R. Warner, Past-President of the society. There was also an article which appeared on May 4, reviewing a booklet by Chief Smoke Inspector Roberts, Past-President of the society.

It is worth stating that on account of limited time a review could be written for the one newspaper only, while the booklet itself was handed the other leading newspaper. The latter did its own reviewing and gave the book some 2 in. of formal publicity, but the former published the review in full as written by this committee and followed it with an editorial in the next issue on the benefits accruing from a lessening of the smoke nuisance.

The combined circulation of the two leading newspapers, the *Plain Dealer* and the *Leader*, is Sunday editions, about 240,000, week days about 190,000 copies. From these figures some idea may be gained as to the number of people reached.

Besides the publicity in the local field the committee has done some work in a wider field. The relation between effort and result has been about the same in either field. It would seem, from our short experience in Cleveland, if other engineering societies over the country would endeavor to get in touch with the public through the medium of the newspapers, both the engineering profession and the public would be gainers.

C. E. DRAYER.

Chairman, Publicity Committee, Cleveland Engineering Society.

1801 E. 93d St., Cleveland, Ohio, May 7, 1913.

[Comment on this letter and related topics may be found in our editorial columns.—ED.]

The Flood-Prevention Problem

Sir—Referring to your editorial on page 791, issue of Apr. 17, 1913, the officers and members of the National Drainage Congress appreciate your commendation to your readers of the admirable address delivered by Col. C. McD. Townsend at the National Drainage Congress in St. Louis, Apr. 10 to 12, and venture to express the hope that you will continue to aid us in our effort to educate the people of the United States to the knowledge that river control and flood prevention are not local questions, to be solved by local effort, independently and without regard to the problems of other sections.

It is a fact, though it seems almost incredible, that some prominent men of intelligence seem to believe that by means of reservoirs and reforestation an entire solution of this problem is offered, and it is equally as incredible that others urge that construction of levees and bank revetment on the lower reaches of the Mississippi is all that is necessary.

The National Drainage Congress insists that there is no one cure-all or universal panacea for this trouble. It is a disease which requires national diagnosis and harmonious treatment of all members. The plans of the Pittsburgh Flood Commission must be accepted as the best solution for the flood question at Pittsburgh, according to our present knowledge, and the plans of the Mississippi River Commission must be similarly accepted as the best solution now known of the flood question from Cape Girardeau to the mouth of the river; but neither of these plans help the flooded areas of Ohio and Indiana, the upper reaches of the Mississippi, or the Sacramento and San Joaquin Valleys of California.

The National Drainage Congress, though heartily in sympathy with these various independent projects and having the utmost admiration and belief in the men who have made these plans and are advancing them, does not indorse any project, no matter how tremendous and important. Following the example of the Rivers and Harbors Congress, we declare for a plan and not a project, and our plan is that Congress shall create a body which shall put in effect at the earliest possible moment such plans for coöperation with the several states and such other agencies as will meet the needs of the several localities of the United States; and we believe that the most effectual and direct means of accomplishing this coöperation and construction will be the establishment of a Department of Public Works, with a Secretary in charge, who shall be a member of the President's Cabinet.

As Isham Randolph says:

> The public works of the United States suffer because they are not concentrated under one responsible head. They are like orphans laid upon the doorsteps, to be cared for as best they may by sundry benevolent departments of the Government. These public works are national and correlated, and to secure the best results they should be grouped in one department under one responsible head, who can so organize all these activities as to make one coördinated, coöperative and efficient machine out of the now scattered parts.
>
> The day for commissions is gone by. We do not need to have a diagnosis of a catastrophe here and another there, each to be treated without reference to the other. What we need is a plan big enough to compass the land and so well considered that the work most needed can be first begun, and when it is finished it will be so much accomplished in the work of a great comprehensive project; and so will each successive component section of the plan be taken up in the order of its need, until the last section is reached, and the mighty work stands complete; a monument to the brains that planned and the energy and skill and well applied labor that accomplished all. Such a work as this is not for a decade or for a life-time, but to be carried forward long after its designers have been gathered to their fathers.

It is also the declaration of the National Drainage Congress that the government alone has power to so coordinate the interests of the government, the states, the corporations and the individuals as to successfully carry out such a comprehensive plan and to proportion the expense incidental thereto.

There are many state complications, such as the St. Francis Basin between Missouri and Arkansas, the Dismal Swamp between Virginia and North Carolina, and other instances beyond number which need government supervision; and we are thoroughly in accord with Col. Townsend in stating that this expense shall not be borne by the Government, but shall be equably divided among those who profit.

On the grounds of navigation, commerce and public health, a certain proportion of these benefits may be properly borne by the United States; where railroad right-of-ways or corporation properties are protected or benefited they should pay in proportion to these benefits; and where primarily or incidentally swamp or overflowed lands are drained and protected, these lands should pay for such reclamation and protection; and where states, counties and other taxing bodies have their revenues increased, this should also be considered.

The government itself, with proper appeal, should be the one to decide absolutely and impartially, as is done by the Reclamation Service, as to when and where these improvements should be made, and again the government, with proper appeal, should be the one to apportion the benefits and damages among those affected.

The third insistence on our part is that it is not necessary for the government to hide behind the pretense of navigation and commerce in doing this work. Article I, Section 8 of the Constitution of the United States reads: "The congress shall have power to levy and collect taxes, duties, imports and excises, to pay the debts and provide for the common defense and general welfare of the United States." We believe that this term, common defense, includes defense from the internal enemies of the forces of Nature, which cause death and disease and loss of property, as well as defense against foreign foes of human kind, which cause no other disaster than these same ones of death and disease and loss of property.

This defense may be equally as well provided by our engineers as defense against human enemies is provided by the Army or Navy. Surely "general welfare" means the protection of the lives of our citizens, the protection of their health and their property, and the adding to our national domain of so many million acres, which, now unprotected and a menace to the general welfare, could be readily and profitably converted into agricultural lands, to lower the cost of living, and provide homes for hundreds of thousands now cooped in the great cities.

EDMUND T. PERKINS,
President, National Drainage Congress.

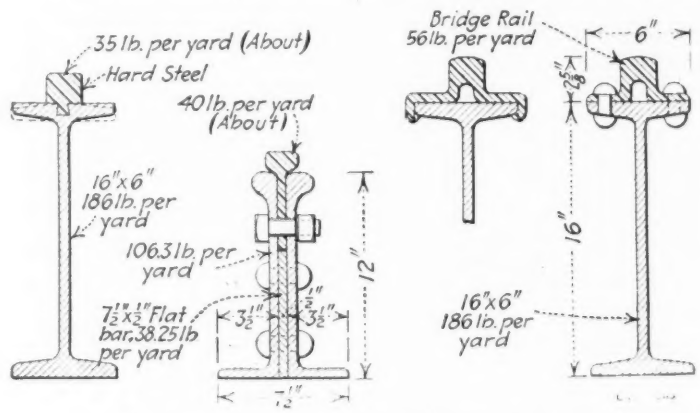
Chicago, Ill., May 1, 1913.

❖

Suggestions for Compound Rails from Australia

Sir—I have been for years, though in a desultory manner, thinking over the question of improved rails. This is driven home to us here in Australia in common with the rest of the world.

The best rails we ever had were 30-lb. rails laid in 1880, for about 35 miles on a branch line 200 miles north of here. Wherever I required good steel for any purpose these rails were used. We also got 41¼-lb. rails about 1880 and for some years these were also good as were the



SUGGESTIONS FOR COMPOUND RAILS

60-lb. rails bought about 1890; but since then there has been a great falling off in quality though the specification is the same, and the worst are 75-lb. rails laid two or three years ago.

Some years ago I made suggestions for compound rails, the head to be very hard and in short lengths and to be bolted or riveted to two channel irons set on edge. However, as ordinary rails were good enough for us with our light loads, I never went beyond talking to my assistants.

About six months ago, however, inspired by articles in your paper, I made several pencil sketches and gave

AN OVERSHOT WATERWHEEL ORIGINALLY BUILT IN 1650

them to Mr. N. G. Bell, our present Chief Engineer, who made drawings for me. These I now forward to you.

Both the pencil sketches and blueprints are intended more as suggestions than as actual proposals; and I merely send them as showing that people on this side of the Globe have similar ideas running through their minds to those of American engineers.

So far as I recall I never saw any drawings of compound rails till I saw the illustration of the rails for Chicago street railways in your issue of Jan. 23, 1913.

W. PAGAN.
M. Inst. C. E.

Brisbane, Queensland, Mar. 26, 1913.

[We reproduce herewith Mr. Pagan's sketches of girder rails with a separable wearing member of hard steel. As our readers who have studied this problem in detail are aware, many points must be kept in mind by the designer of a successful compound rail. Width of the head, conditions at joints, wear between the upper and lower parts, facility of bending for curves, stability against lateral stress, are a few that may be mentioned.

Perhaps the most interesting point in Mr. Pagan's letter, however, is his testimony that rail steel in Australia, purchased probably from British rail mills, is as unsatisfactory as that of which American engineers complain. With all the progress that has been made in alloy steels, heat treatment, inspection, chemical control of furnace mixtures and what not during the past 30 years, why is it that rail makers cannot produce as good quality steel rails as they did thirty years ago? Or is it a matter of will not instead of cannot?—EDITOR.]

A Really Old Overshot Waterwheel

Sir—The description of the old-time overshot waterwheel, in your issue of Mar. 20, recalls to my memory a much more venerable one. The accompanying photograph shows Gov. John Winthrop's mill, which was built by him under charter from King Charles II, in 1650. This grant was made by King Charles to endure "as long as trees grow and water runs."

The present wheel is exactly of the same design as the original wheel; but it wears out, of course, about every 20 years, and has been rebuilt many times, without change from the original design.

All the stonework is granite and the frame of the building is of hewed white oak. The wheel develops about 18 hp., is 18 ft. in diameter and about 6 ft. in width of buckets. The mill stands in a park on the outskirts of New London, Conn., and can be seen from the trolley cars which run between New London and Norwich.

I think this mill, built in 1650, is, without doubt, the oldest power station in existence on this continent. There are many references to this mill in the early records of the Connecticut Colony.

GEO. A. ORROK.

55 Duane St., New York., Apr. 17, 1913.

The Tests of the Norcross and "Mushroom" Flat Slabs

Sir—It seems to me that the tests on flat slabs by Dr. Henry T. Eddy, described in ENGINEERING NEWS, Mar. 27, 1913, p. 624, merit some comment.

The natural inference that one will make, on account of these tests being placed side by side, is that they are comparable as solutions in two ways of the same problem. It is pertinent, then, to lay the conditions of the tests side by side and compare first the conditions before the results are compared, to see if these are fair.

You mention editorially the absence of tensile reinforcement over the columns in the Norcross slab. There are other differences between this and the "mushroom" slab, and they are all unfavorable to the Norcross slab.

The Norcross slab was 16 ft. square and the columns were in a 12-ft. square. This leaves 2 ft. of an overhang in place of 2½ ft. as stated. The "mushroom" slab was 18 ft. square and the columns were in a 12-ft. square. This leaves 3 ft. of an overhang, 50% more than the other. This overhang is a very important feature. It balances load over the column and relieves bending moments between the columns.

The Norcross slab rested on steel plates laid on top of small gas-pipe posts. This is unheard-of construc-

tion. The "mushroom" slab was built integral with short heavy columns with large expanding heads, reinforced with steel. Each of these big columns would require a very considerable load to upset it, if severed from the slab. It would be difficult to balance much load on the gas-pipe arrangement without upsetting it.

Why were man-sized columns used to support this small "mushroom" slab? Why not columns merely strong enough to carry the vertical load? The column does not enter in the supposed analysis of the "mushroom" slab; it is supposed to carry only vertical load and not bending. These short, heavy columns would carry a large bending moment which has no relation to that which a high and heavily-loaded building column could carry.

Why were the first loads placed on the slab-balancing loads, that is, half on the overhang and half in the square between columns? The severe condition of loading is just as apt to be realized in a structure as any other.

EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Penn.,
Apr. 3, 1913.

Sir—As you suggest in your editorial comment upon Dr. Eddy's article in the issue of Mar. 27, there is little of interest in the test of a slab such as Dr. Eddy calls the Norcross slab.

Why should the article be headed "A Comparative Test," etc., when the two slabs, viz., the Norcross and "mushroom," are not to be compared. Looking at the construction, it will be understood that the Norcross slab of nearly 12-ft. span, is not continuous, and is supported on 5½-in. columns around which the shearing stresses must be very large. The "mushroom" slab, on the other hand, has large and stiff column-heads, and 12x12-in. columns. It corresponds to a continuous beam, and the span between the points of inflection directly between the columns is probably not more than 6 ft.

The merits of the practical flat-slab system, as used in buildings, as for instance, the Akme system, the Corr-Bar system and the Cantilever Flat-Slab system are conceded, and are attained by proper attention to designing stiff column-heads, and providing proper reinforcement over the column. We know that the compressive stresses must be examined carefully, and that the maximum steel stresses are to be found over their column-heads. The merit of the Turner system does not need to be shown by knocking down a man of straw like this Norcross slab described by Dr. Eddy.

Fig. 8 in Dr. Eddy's article seems to show the maximum stresses to be over the column caps, yet Dr. Eddy's report of steel stress is for points in the center of the span where these stresses are not maximum.

What were the stresses near the column caps, both in compression and tension?

New York, Apr. 3, 1913.

X. Y. Z.

[The foregoing letters were submitted to Dr. Eddy, who has replied as follows.—ED.]

Sir—Referring to the two letters to be published in ENGINEERING NEWS, I have turned the matter over to C. A. P. Turner, and am submitting herewith a letter to be published, commenting upon these letters in preference to making any reply myself.

H. T. EDDY.

Milwaukee, Wis., Apr. 22, 1913.

Sir—Referring to the letters of Mr. Godfrey and another, criticizing the article of Dr. H. T. Eddy in "Engineering News," Mar. 27, 1913, in which he discusses a "Comparative Test of Two Flat Slabs," the present writer wishes to assume the entire responsibility for the design of the test slabs. Dr. Eddy was merely requested to discuss and elucidate the results obtained in course of the test. It will have to be acknowledged that he has done this with a completeness that leaves no doubt as to the nature of the constructions and their theoretical explanation.

The writer finds himself in complete and hearty agreement with Mr. Godfrey's impatient characterization of the Norcross test slab as an "unheard of construction" and a "man of straw." Such it is and nothing else, and the present writer would have assumed that everyone was of the same opinion also had not this Norcross patent been made the basis of a suit in equity in which the claim is made in pretended good faith that the Norcross construction with strips of hog-wire netting in the bottom of the slab for reinforcement is identical with and has the same merit as the Turner "mushroom" construction. The original specifications of the Norcross patent suggested the reinforcement to be made of hog-wire netting and the patent claims were allowed, as would appear from the file wrapper, on the ground that hog-wire netting was an improvement over rolled shapes or bars. It is of record that the claim of direct and diagonal strip reinforcement had been rejected in case of the prior Seeley patent. It was not then so absurd as it might at first appear to be to put a final quietus on the pretense that there might be some similarity between the two. The writer is pleased to know that this is so self-evident that even Mr. Godfrey thinks the effort to establish the incontestible truth of this position is trying to knock over a man of straw. He could ask no more emphatic indorsement of his contention.

Referring to the other letter, not signed, while it is true that the total stress that must be resisted by the reinforcement is undeniably greater in the "mushroom" system around the column than it is in any other part of the slab, it is also true that the intensity of the stress per unit of steel depends upon the cross-section of steel which resists that total stress. But on account of the massing of metal in the vicinity of the column the intensity of stress in the reinforcement here does not exceed that at other points. The 18-in. column used in the "Mushroom" test slab is the smallest size of concrete column we use in ordinary design.

This "Mushroom" test slab is quite similar to many bridge slabs that have been constructed with the same overhang at the edges, and with spans up to 50 ft. from center to center of columns.

C. A. P. TURNER.

Milwaukee, Wis.,
Apr. 22, 1913.

NOTES AND QUERIES

In the editorial on "Grouting Gravel in River Beds," in our issue of May 8, we intimated that the experiments described in that issue were made with a view to the possible use of this system for the foundations of the Cumberland River bridge of the Louisville & Nashville R.R., at Nashville, Tenn. We were misinformed as to this as solid limestone rock is found only 15 to 20 ft. below the surface at the bridge site, and all the piers are founded on rock, except one which is on concrete piles. The construction of this bridge was well advanced before the experiments were commenced, and they were made at that particular place merely to take advantage of the gravel bar and the existence of the contractor's equipment which could be used for the work.

A note concerning the biography of Edwin F. Wendt was inadvertently omitted from our article in the May 15 issue on "The Railway Valuation Board of the Interstate Commerce Commission." Mr. Wendt, as most of our readers will remember, was recently elected President of the American Railway Engineering Asociation, and a sketch of his life and work was published in our issue of Mar. 20, p. 591.

A Hydraulic Speed-Change Gear or Variable Speed Power Transmission*

The theoretical advantage of a hydraulic variable-speed power-transmission gear of the pump-and-engine type, a positive drive with infinite gradation in speed steps from a maximum in one direction to maximum reversed, has long been recognized. The number of inventors who have worked on such schemes testifies to the attractiveness of the idea, but the few completely successful devices evolved show that heavy mechanical difficulties have been encountered in perfecting design and construction.†

The gear shown in the accompanying figures has been in evolution at the hands of the present makers for some seven years. After two years' work, the first machine was sold to the government for elevating a 12-in.

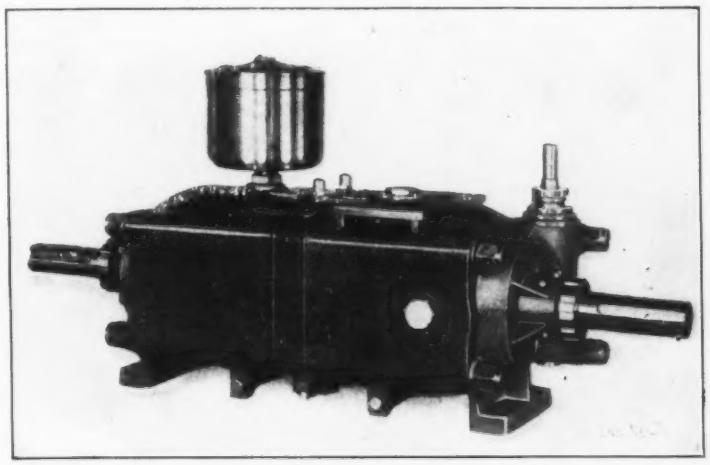


FIG. 1. THE WATERBURY HYDRAULIC SPEED-CHANGE GEAR ASSEMBLED

naval gun. This service was successful and was followed by other service until, it is claimed, somewhat more than 500 machines have been delivered for gun and turret control. The gear has been tried out also for motor cars, marine propulsion, drawbridges, cranes, hoists, machine tools, etc.

The complete transmission device is made up essentially of two parts, an oil pump designated by the makers as the "A-end" and an oil engine designated as the "B-end." The A-end may be driven by any source of power and is supposed to run at a constant speed in one direction. By a small control shaft on this end, the stroke of the pump pistons is changed to vary the delivery of oil to the engine. The B-end has a constant cylinder displacement per shaft revolution, so that speed of the driven shaft is determined by the rate at which oil is supplied to the B-end by the pump. No oil is bypassed and the leakage is very small between high and low-pressure spaces, averaging about $^{13}/_{100}\%$. There is practically no leakage from the gear as a whole, since the major part of the oil supply (that in the outer casing) is at atmospheric pressure only.

Fig. 1 gives an external view of the gear in its most compact form (called "type C" by the makers). In this type, the pump and engine mechanisms are combined into one working unit; the power enters the casing by the driving shaft which rotates at a constant speed, and comes out at the opposite end by the driven shaft, which rotates at any required speed and in either direction. The small vertical stud shown in the figure at the right (A-end) is the control shaft; the direction of rotation of the driven shaft is determined by the direction in which the control shaft is rotated from its zero position, while the speed of the driven shaft is determined by the angle through which the control shaft has been rotated. (When the pump and engine ends are further apart and connected only by piping, "type K" is the maker's designation.)

On top of the engine end is an oil expansion box communicating with the oil in the machine and vented to the air. The inclosing shell of the gear is filled with oil, although only a small portion of the oil is under pressure and active in transmitting power.

In Fig. 1 the pump and engine are directly united by a common valve plate which is located across the middle of the machine and through which the oil is circulated between the two ends. This valve plate may be made in almost any shape, permitting the placing of the two mechanisms at any angle or in any position with reference to each other. Each end may be provided with a separate valve plate and located in any desired position, the oil circulation being provided for by connecting pipes; there may be two or more engine ends remotely disposed to meet special requirements, as in motor vehicles.

In Fig. 2, the outer cases are removed, leaving the internal parts, the two shaft groups being separated a little from the valve plate, and the angle and tilting boxes being pulled away from the socket rings.

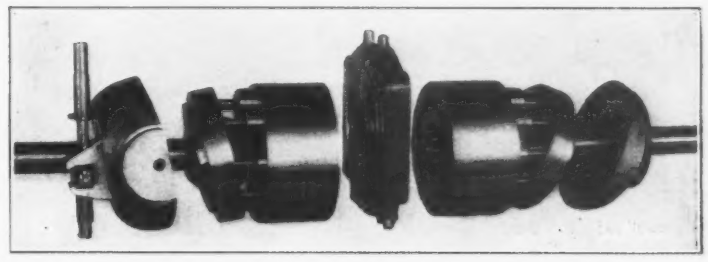


FIG. 2. VALVE PLATE, PISTON BARRELS, SOCKET RINGS, THRUST BLOCKS AND SHAFTS

THE VALVE PLATE—The valve plate stands in the middle of Fig. 2; it is also shown alone in Fig. 3. Passing through the plate about half way between its center and periphery are two semi-annular passages. These are for the circulation of the oil between the pump and engine cylinders. When the gear is transmitting power one of these passages is under positive pressure above atmospheric while the other is in suction. These two functions are changed according to the direction of rotation of the driven shaft. Connected with the passages are three pairs of valves: at the top are two small air needle valves used only for the escape of air from the passages and cylinders while being filled with oil; at the bottom are two ball-check valves used for replenishing any leakage that may take place from the high-pressure side to the low-pressure; at the bottom near the replenishing valves are two safety valves to provide relief should the gear be overloaded. There is also connected with each passage, near the top, a plugged hole for attaching gages in case it is desired to measure the oil pressure, or load carried. Near the top of the valve plate, and also in connection with all the valves, there

*From information furnished by the Waterbury Tool Co., New Britain, Conn.

†See "Engineering News," Feb. 18, 1909, and Oct. 31, 1912, for two hydraulic transmissions which seem to have been brought to a reasonable degree of practical utility.

are holes passing through the plate giving free circulation of the oil between the two ends of the gear within the inclosing cases, or shells. There are also bolt holes for securing the cases. In the center of the plate are roller bearings for the inner ends of the shafts.

Shaft Groups—The shaft groups of parts in the two ends are almost identical. A cylinder barrel is keyed to the inner end of each shaft, but slides freely along it. Each barrel has nine cylinders, parallel with the shaft and fitted with pistons provided with ball-ended connecting rods. The faces of the barrels in their revolution bear against the faces of the valve plate, and the cylinder ports in the barrel faces register with the semi-

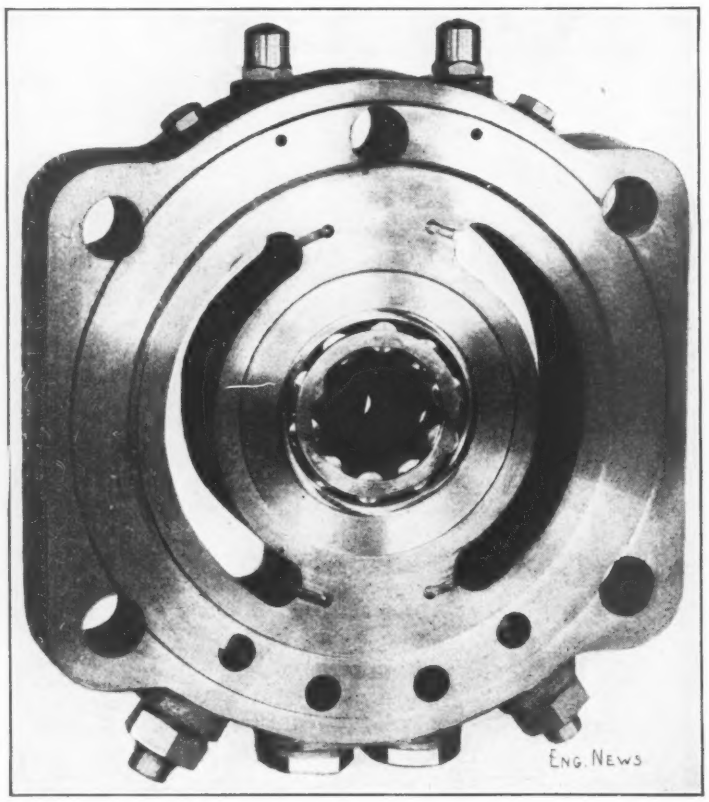


Fig. 3. Valve Plate Face of Waterbury Variable-Speed Transmission

annular passages except as they are passing over the separating lands at the top and bottom of the plate. The barrels are held lightly against the faces of the valve plate by spiral springs around the shafts, which are compressed between shoulders on the shaft and counterbored recesses in the barrels. These springs are intended only to hold the barrels in position under no load; when the gear is transmitting power, the barrels adjust themselves. By giving the port width and piston areas definite relations and by determining the proper contact surface on the valve plate, the oil-film pressure tending to separate the cylinder barrel from the valve plate and the internal pressure on the inner ends of the cylinders on each side of the ports are balanced; the oil film between the cylinder barrel and the valve plate is automatically regulated in thickness so that leakage is comparatively uniform, it being only about enough to provide general lubrication. A fiber disk between the inner ends of the two shafts divides the bearing chamber.

The piston connecting rods are formed with a ball on each end of each rod, one ball end being secured in a piston and the other in a socket in the socket ring. These rods have holes from end to end for the passage of oil under pressure for lubrication. The socket rings are connected by special universal joints with the shafts, so that while they revolve with the shafts, their planes of revolution may be at any angle to the shafts fixed by the setting of the roller-thrust bearings on which the socket rings bear in revolving. It is well known that, with the simple universal joint, there is a wide variation of angular velocity in the driven shaft with constant velocity of the driver. It is claimed that, by arranging a multiplicity of cylinders and manipulation of the spacing of the pistons, sufficient correction has been introduced for every commercial use.

The Tilting and Angle Boxes—In the engine end of the gear, the socket ring runs in what is called an angle box which is secured in the end of the case itself through which the shaft passes. It stands at a fixed angle of 20°, giving a constant reciprocation to the engine pistons. In the pump end, the box is hung on trunnions and may be adjusted to any desired angle while the gear is running by turning the threaded control shaft which carries a trunnion nut.

Bearings—The socket-ring bearings must carry a very heavy thrust load at high speed and a special alloy steel is used here. To prevent the endwise crowding of the rollers and consequent wearing of the outer ends of the rollers and retaining flanges, particularly at the main thrust bearings in the angle and tilting boxes, the conical rollers and corresponding track surfaces come to an apex some distance short of the axis of the shaft.

There is no side pressure transmitted by the connecting rods, the pistons, or the cylinder barrels, which remain practically parallel.

Operation—The pump shaft, which is connected to the source of power, is supposed to run at a constant speed and in one direction. If the tilting box stands in its neutral position, at right angles to the shaft, the pistons are carried around with the cylinder barrel but do not reciprocate. No oil is, therefore, taken from or delivered to the passages in the valve plate. If, however, the tilting box is inclined by turning the control shaft a little, the pistons reciprocate approximately to the extent of the sine of the angle of tilting multiplied by the diameter of the circle of centers of the sockets in the socket ring. Every cylinder during one-half of the shaft rotation is in communication with one of the passages in the valve plate and is then receiving oil, which it carries across the land and delivers into the other passage during the other half of the shaft rotation. The amount of oil transferred from one passage across to the other passage depends entirely upon the displacement of the pistons. The oil supply comes from half of the cylinders of the engine end. When oil is being forced into one of the passages (already full) the pistons in those engine cylinders in communication with this passage slide back from the valve plate; forcing back their respective sockets and turning the socket ring as a whole in its inclined plane in the angle box. The engine socket ring is always inclined 20° in its angle box so that the pistons always reciprocate to their full extent at every revolution of the driven shaft. While the pistons connected to the pressure passage of the valve plate are receding to make room before the incoming oil, the pistons facing the low-pressure passage are forced toward the valve plate delivering oil from their cylinders through the

PERFORMANCE DATA, DIMENSIONS, ETC., OF WATERBURY HYDRAULIC VARIABLE-SPEED POWER-TRANSMISSION GEARS

Size	5	10	20	35	150
Continuous Service					
Horsepower	12	20	30	50	150
R.p.m.	675	550	450	400	275
Intermittent Service					
Horsepower	15	25	45	70	200
R.p.m.	675	550	450	400	275
Inches length "Type C"	24	30	37	45	74
Lb. weight "Type C"	180	355	700	1230	5240
Lb. weight "Type K"	225	445	890	1500	6600

low-pressure passage into the suction cylinders of the pump barrel. Since the receiving capacity of the engine cylinders is constant and the delivery capacity of the pump cylinders is varied at will by turning the control shaft, the speed of the driven shaft is correspondingly varied. It will be seen that the only oil actively employed in transmitting power is that in the oil passages of the valve plate and in the cylinders. The inclosing outside cases merely serve as a retaining reservoir and are not subject to any pressure.

The oil pressure in the cylinders and valve-plate passages varies directly as the torque resistance which the driven shaft must overcome: the power output varies directly as the product of the oil pressure and the speed of rotation. The normal working oil pressure ranges usually between 300 and 500 lb. per sq.in., but it may rise to 1000 or even 2000 lb. to overcome an unusual resistance. In tests pressures as high as 4000 lb. per sq.in. have been attained.

EFFICIENCY—The great flexibility of such a device necessarily gives wide differences of efficiency. Under the best service conditions efficiencies are claimed ranging from 85% to 91%; under average working conditions these figures are reported to vary between 80% and 85%, while under small loads and low speeds of the driven shaft the efficiencies may drop to 50% or less. At a zero speed, the power efficiency must be zero, but the torque efficiency remains at 95%; torque efficiencies throughout the whole range remain between 90% and 96%.

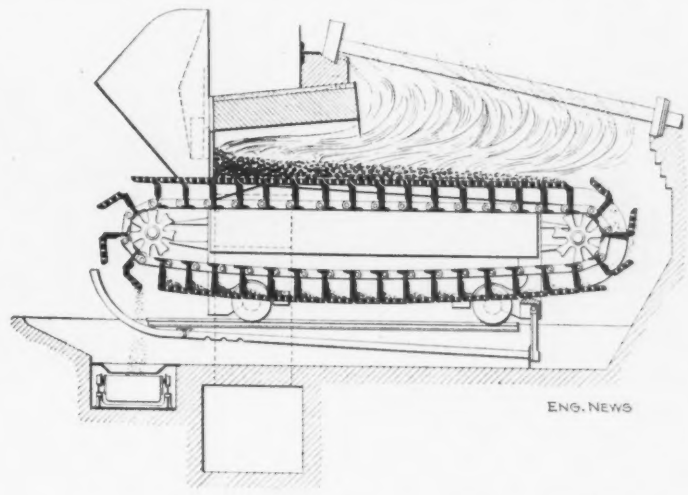
The horsepowers and speeds are as shown in the accompanying table. For regular continuous service the figures are all for pressures of 400 lb. per sq.in. and water cooling should be specified for this service. The figures for intermittent service are for 500 lb. per sq.in.; to meet excessive temporary loads the oil pressures may go to as high as 2000 lb. with proportional torques. Thus, a size-35 unit transmitting 70 hp. at full speed exerts a torque of 918 ft.-lb. with an oil pressure of 500 lb.; but even with the ordinary setting of the relief valves, a load can be started and accelerated with a torque of 1838 ft.-lb. and an oil pressure of 1000 lb. per sq.in. By setting the relief valve tight and running the oil pressure to 2000 lb. a torque of 3675 ft.-lb. can be exerted. For water cooling coils of small copper pipe are led through the outer casing and around the cylinder barrels as close as convenient.

The size numbers given are torque ratings at 100 lb. oil pressure and 63 in. radius, so that the torque exerted by any machine under assumed oil pressure is easily figured.

The design in the present form is the work of H. D. Williams and Reynold Janney, of New York City. Manufacture is in the hands of the Waterbury Tool Co., of Waterbury and New Britain, Conn.

A Chain-Grate Stoker Which Returns Its Ashes

At the new power station of the combined municipal system of Burslem, Fenton, Hanley, Longton, Stoke and Tunstall, in the Staffordshire pottery area of England, water-tube boilers have been equipped with a chain grate of new type, recently developed. This is shown in sectional elevation in the accompanying figure from London *Electrician*, Apr. 11, 1913. The device consists essentially of an endless chain of L-shape grate bars mounted (inverted) on chains, the links of which run over sprocket wheels driven from a countershaft. The tops of the grate bars, of course, are perforated and slotted for the passage of air through the fuel. This air supply enters from two rectangular conduits, one at each side of the stoker near the front end, opening into side-wall recesses of graduated height. This allows automatic variation of the quantity of air to the different parts of the fire; the back receiving the smallest quantity where the fire is thinnest. Conduits also supply air



A CHAIN-GRATE STOKER AND ASH CONVEYOR

to the front and back of the furnace through suitable control dampers. For the three boilers in this plant (each with a steaming capacity of 18,900 lb. per hr.) two fans are employed, each delivering 118 cu.ft. of air per minute.

As shown in the accompanying figure, the shape of the bars is such that when the chain passes over the rear sprocket the ashes left on top of one bar drop to the inside angle of the next forward bar, to be carried along and dumped out of that place when the bars are again separated at the front sprocket. In this way continuous removal of ashes is secured. These grates were made by the Underfeed Stoker Co., Coventry House, South Place, London, E. C., England.

Legislation on Automobiles and other Motor Vehicles in New Jersey, passed by the legislature of 1913, included a joint resolution for the appointment of commissioners to confer with other states on uniform automobile regulation; an increase in the number of automobile inspectors from 10 to 16 with a salary of $1350 each; permitting the state motor commissioner to issue a formula on Dec. 1 of each year for the computation of horsepower of automobiles; and giving to the state road commissioner and to county and municipal officials the power to control the moving of heavy road engines and other vehicles over thoroughfares and bridges with authority to give permits for such movement specifying conditions under which the movement may be made.

A Hollow Steel Slab Floor

In deciding on the floor construction to be used in a fireproof building, light weight and speed of erection are often vital factors. Both advantages are possessed in a marked degree by a material which has been on the market for five or six years, but is not well known and correspondingly has had rather limited use. It is a closely folded steel sheet, and may be regarded as a specialized form of trough flooring. It constitutes a hollow steel slab 2 in. thick weighing only 4½ to 5 lb. per sq.ft., yet capable of carrying ordinary and even heavy warehouse floor loadings on spans of 4 to 6 ft. The flooring is called "Cellular Metal" and is now made by the Edwards Manufacturing Co., Cincinnati, Ohio.

The view, Fig. 1, illustrates the method in which this "Cellular Metal" is applied. The job shown by the view was done two years ago and is chosen for illustration in preference to a more recent job because it illustrates work rather more difficult than a floor in an ordinary building. The auditorium floor shown is both sloping and dished. In this theater building both the auditorium and the mezzanine floors and the roof were made of "Cellular Metal." The particular construction used for the floors is given by a right-hand sketch in Fig. 2, showing 1½ in. of concrete laid over the steel, and wood flooring laid on the concrete by means of nailing strips and cinder filling; and plaster applied on the bottom of the "Cellular Metal" as ceiling finish. In the case of the auditorium floor the "Cellular Metal" was laid on the beams, but for the mezzanine it was laid on shelf angles riveted to the backs of channels used as floor joists, in order to keep the depth of floor down to a minimum. The roof construction used in this same building employed the plain "Cellular Metal" (i.e., without dovetail grooves in either face) as shown on the left in Fig. 2, and composition roofing was laid directly on the top surface of the steel, without any concrete.

The auditorium has its steel floorbeams spaced five to six feet apart, supported by brick piers, and the "Cellular Metal" flooring thus has spans of 5 to 6 ft. Its capacity is given as 150 lb. live-load. The weight of the floor, with the 1½-in. thickness of concrete on top, is given us by the manufacturers as about 25 lb. per sq. ft. of floor. For the total weight of floor there must be added to this the weight of plaster on the under side and the weight of sleepers, fill and wood flooring on top. The total weight, however, remains far enough below that of other forms of floor to make a material saving in strength of frame possible.

As this steel flooring is likely to prove convenient and desirable for various cases of temporary or permanent construction, we show in the sketch (Fig. 2), herewith, cross-sections of the three forms in which it is made. They are alike except for the dovetail grooving of top and bottom faces, which is provided for giving a key for plaster below or concrete on top. The "Cellular Metal" is made in widths of about 6 in. and in lengths up to 11½ ft. Sections side by side are joined by sliding together, as illustrated in the right-hand sketch in Fig. 2. How much fastening should be provided between the metal slab and the floor beams will depend on the de-

FIG. 1. LAYING HOLLOW STEEL FLOORING IN AUDITORIUM OF HARRIS THEATER, PITTSBURGH, PENN.

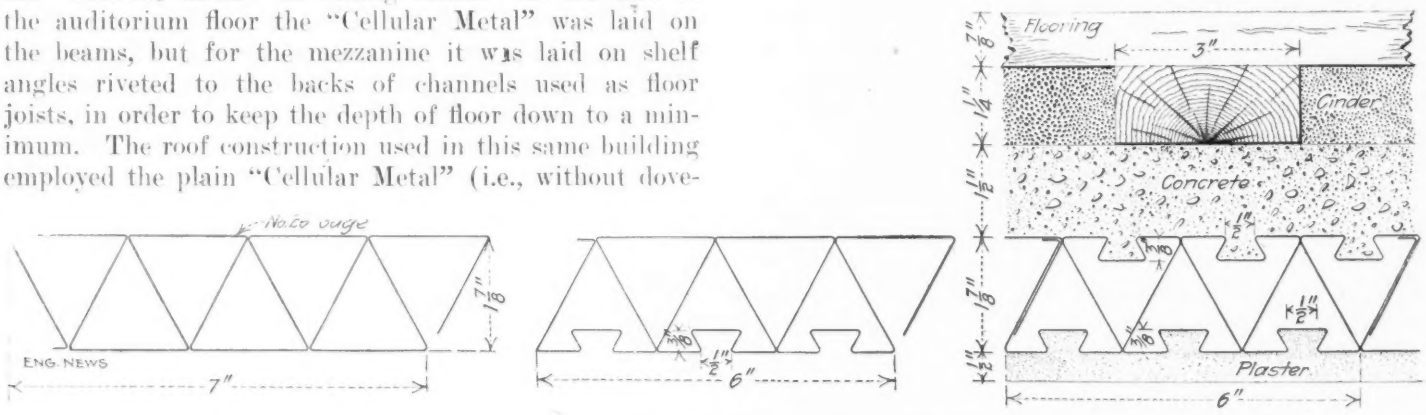


FIG. 2. SECTIONS OF CELLULAR METAL WITH AND WITHOUT DOVETAIL GROOVES

(Section at right represents floor as laid in auditorium of Harris Theater, on spans 5 to 6 ft. The section without dovetails, at left, was used in the roof of the building, composition roofing being laid directly on the steel.)

signer's judgment; the manufacturers recommend fastening every third width by clips.

The material has been tested for load capacity, etc., As long ago as 1906 a floor constructed of "Cellular Metal" with 3 in. of concrete on top, the floor spanning 6 ft., was put through the regulation load-fire-and-water

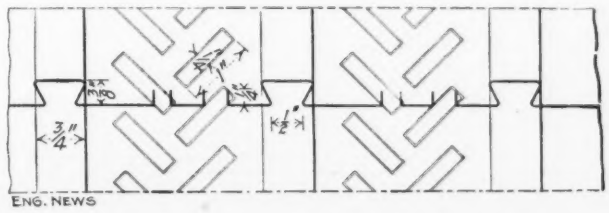


FIG. 3. "KEYRIDGE" METAL, USED IN PARTITIONS AND SUSPENDED CEILING OF HARRIS THEATER

test of the Bureau of Buildings, New York City, and passed the test, receiving approval for loadings of 150 lb. per sq.ft. on spans up to 6 ft. Tests were made two years ago by John W. Hill & Sons, consulting engineers of Cincinnati, Ohio, and as a result they recommended the table of safe loads given below.

SAFE LOADS FOR CELLULAR METAL FLOORS

Live-Load in Pounds per Square Foot, from tests by John W. Hill & Sons, Cincinnati, O.

Slab 3.06 in. thick, incl. Cellular. Weight 20.63 lb. per sq.ft. Age 18 months Mix 1 : 4			Slab 4 in. thick incl. Cellular. Weight 32.42 lb. per sq.ft. Age 18 months Mix 1 : 4		
Clear span, ft.	Safe load	Deflection, inch	Clear span, ft.	Safe load	Deflection, inch
3	1298	0.049	3	2333	0.039
4	728	0.087	4	1310	0.070
5	464	0.135	5	835	0.109
6	321	0.194	6	577	0.156
7	234	0.263	7	422	0.212
8	178	0.341	8	321	0.275
9	140	0.429	9	252	0.345
10	112	0.523	10	203	0.422
11	92	0.629	11	166	0.508

Note: The tests were on No. 24 gage Cellular Metal. The safe loads are one-quarter of the net breaking loads.

A companion material also used in the building shown by Fig. 1 is a special form of self-furring metal lath, or partition-framing material, made by the same manufacturers. This is sketched in Fig. 3. It is called "Keyridge." In the Harris Theater it was used for the ceiling under the roof trusses, in the reinforced-concrete balcony, and in various partitions in the building. A solid 2-in. partition of "Keyridge" plastered on both sides is said to require no studs. The ceiling metal was supported by hangers at 5-ft. spacing, without studs or furring channels.

This "Keyridge" is made in sheets 24 in. wide and in lengths up to 12 ft., of gages from 24 to 28. Used as reinforcement for concrete slabs it was tested by John W. Hill & Sons in slab thicknesses from 1⅞ to 4½ in. The 1⅞-in. slab gave a safe load (equal to one-quarter the net breaking load) of 98 lb. per sq.ft. on a 5-ft. span, and 21 lb. per sq.ft. on a 10-ft. span; the 4½-in. slab gave a safe load of 231 lb. per sq.ft. on a 5-ft. span and 49 lb. per sq.ft. on a 10-ft. span.

The Grounding of Transformer Secondary Circuits has been ordered by the Public Utility Commission of the Province of Quebec in the cases of the Quebec Railway, Light & Power Co. and the Dorchester Electric Co. The Canadian Fire Underwriter's Association asked for this ruling, and recommended that the grounding be through the water mains of the city. The Commission, therefore, instructed the companies to approach the Quebec City Council to secure permission to comply with that recommendation.

Fatal Failure of Overloaded Wooden Floor at Long Beach, Cal.

Thirty-five persons were killed at Long Beach, near Los Angeles, Calif., by the failure of a wooden floor at noon, May 24, 1913. The floor was an approach from the upper deck of the city pier* to the second floor of the city auditorium, built some years ago. It led to the west entrance of the auditorium. A celebration was in progress, and a great crowd was about to enter the auditorium. Closed doors or some stoppage of the movement of people brought a dense crowd of people upon the approach, and the floor broke down. The crowd was dropped 13 ft. to the lower floor, and this in turn broke and dropped them five or six feet more to the sand beach (the tide was out). Injuries from the struggling people, and suffocation of those underneath, were the causes of death. Many were injured.

The following is an approximate (but not exact) statement of the structural facts. The approach was wholly of wooden construction. It had a 1-in. board floor on 2x12-in. wooden joists spaced 2 ft. apart. Two bays of these joists were carried on a transverse girder 18 ft. in span, whose section was 4x14 (two 2x14-in. sticks). The east bay of joists had a span of about 11 ft., and the west bay a span of about 14 ft., so that the girder carried a floor area of 18x12½ ft., or 225 sq.ft. The girder broke.

It is said that the ends of the girder had developed decay in the interior. The bearing of this question on the collapse will have to be determined by the official investigation. The manner in which the ends of the girder were supported is to be considered in connection therewith.

The ends of the girder were carried by 12x12-in. posts; the girder was mortised into the post 4 in. deep, so that it probably had a bearing of less than 4x4 in. at each end. There was also a kneebrace from post to girder: a stick about 3x6 in. or less, nailed to the face of the post and to the bottom face of the girder, with a reach of about 3 ft. The effect of the kneebraces in reducing the effective span of the girder is problematical, but this subject will doubtless be weighed by the investigating board.

On the face of the figures the girder was much the weakest part of the floor and was incapable of carrying a dense crowd. The full investigation of the design is likely to be important. An approximate estimate on the basis of the data noted indicates that a moderate crowd of 60 lb. per sq.ft. of floor would stress the girder to 2500-3000 lb. per sq.in., whereas working stresses range from 1000 to 1500 lb. per sq.in. This estimate is subject to correction of data from the official investigation.

The city promptly took charge of the care of the victims of the accident, and subsequently appointed an investigating board of architects and engineers. Pending full examination and report by this board accurate or complete data cannot be given.

The approach that failed was not part of the pier contract, but part of the building contract. Like the pier and the auditorium it was municipal property.

The accident is specially deplorable because most of the victims were women.

*For part of the pier history see Eng. News, 1910, II, 67, 185.

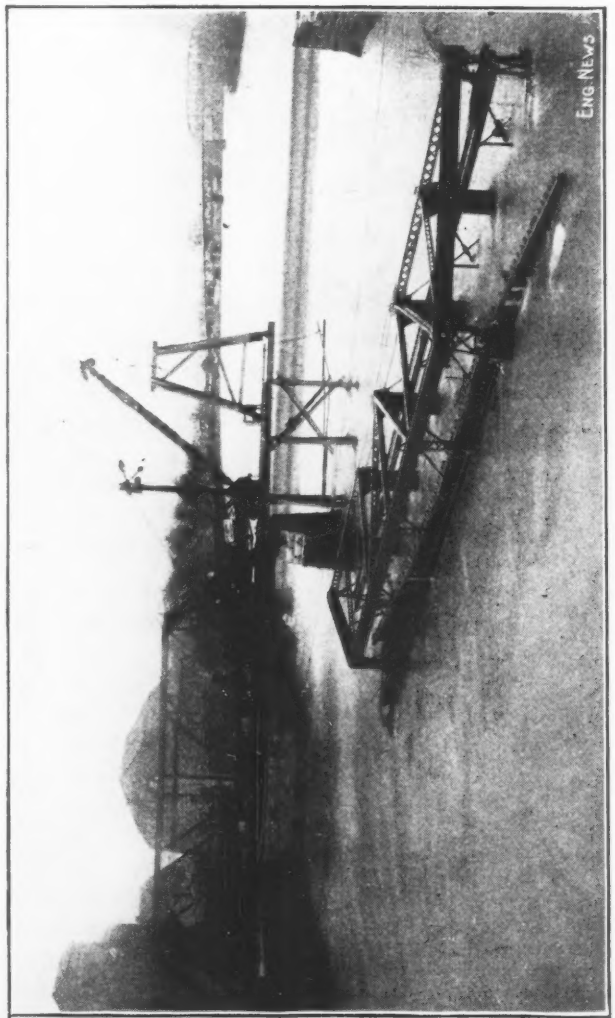


FIG. 3. TRESTLE BUILDING FOR RESTORING THE B. & O. CROSSING
(Water is still high; but note dam and compare with Fig. 1.)

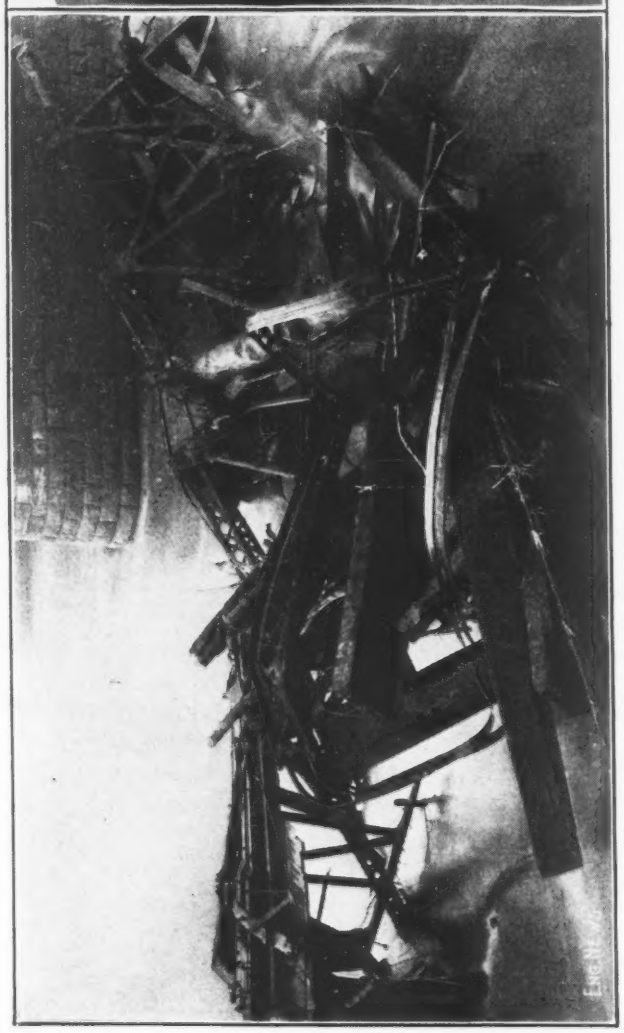


FIG. 2. WRECKAGE OF EAST SPAN OF B. & O. BRIDGE AT ZANESVILLE, LYING UNDER ARCH OF Y-BRIDGE

Rebuilding the Zanesville Bridge, Baltimore & Ohio R.R.*

Three railroad bridges went down in the flood at Zanesville. Some trains of all three roads have been running over the wooden structure which the Baltimore & Ohio built in less than eight days. The task looked impossible. The structure had to be placed in a swirling current, under the very edge of a fall, where soundings could not be made, where piles could not be driven. The river bottom was an unknown quantity.

On Sunday, Mar. 30, a little company, including Paul Didier (Prin. Asst. Engr.), G. A. Schmoll (Supt. M. P.) and G. F. Cunningham (Res. Engr.), arrived at CD tower, over two miles out of Zanesville. The tracks were impassable and they tramped into town by a five-mile route over the hills. The town was patrolled by soldiers, which made it hard at times for the railroad men to get around. They could scarcely get their reports to the telegraph office.

The water at the fall had risen during the flood to a height of 38 ft., or 16 ft. above the record of 1898. [See view Fig. 1, taken when the water had fallen somewhat below maximum stage. The surviving span of the B. & O. bridge shows at the extreme left, 80% submerged. In front of it is a ripple where water flows over the Y-bridge. The old bridge had withstood the pressure surprisingly well. In the drift that bore against the sides were three or four cars, parts of many houses and a great mass of undistinguishable wreckage. When the first span went down it was jammed through the low arch of the Y-bridge below. [See Fig. 2.] Two more spans followed.†

By the time Mr. Didier arrived, the water had gone down from 38 to 18.8 ft., with 12.5 ft. going over the dam at twelve to fourteen miles an hour.

"The bridge was gone when I got there," said Mr. Didier. "It looked like a funeral, and they expected me to act as undertaker."

Meanwhile D. A. Williams, the storekeeper, and W. H. Clifton, the lumber agent from Baltimore, were out on a great hunting trip for materials, and when it was time to begin the bridge the stuff was there.

Two cranes came, and W. M. Clark, Master Carpenter, organized a force of carpenters from Philadelphia, Baltimore and Pittsburgh, his own headquarters. On Friday, Apr. 4, a monkey-bent—two short beams with a piece over the top—was set upon a ledge of rock halfway down the bank, to prepare for beginning the work. By Saturday the water had fallen to 12 ft. on the gage and 6 ft. over the dam. It was decided to risk a bent in the river. On Sunday the first water-bent was placed. It dangled from the crane, dropped into the water and got its footing like a man on a pair of stilts. One end might strike a rock and the other a hole, in which case it was hauled up and sawed off till the top stood level. A rough john-boat or scow, of the width to be maintained between bents, was launched and held in place by ropes from shore. In each case the foot of the new bent was drawn against the outside of the boat and held there by ropes till it could be made fast to the structure. Stringers and bracing were fitted rapidly in place. The crew of carpenters always had timbers cut and ready before the bridgemen needed them.

As Mr. Didier said, "the water was both fierce and treacherous." Not a bent nor a tool was lost.

At the beginning the question of night work arose, but the risk was too great. The men appreciated the decision to do without it. Fourteen boxes of carbide had been furnished for light, but no torch was burned.

After the work was fairly under way a new bent was placed every two or three hours. The last of the 25 bents was set Apr. 11, five days from the beginning. Two plumb-posts were fitted into the middle of each bent. These also had to be dropped as far as they would go, marked, raised and cut the right length; then the top structure was quickly laid on. A temporary track had been used for the cranes. This was taken up and bridge ties and new rails were laid.

On Sunday, the thirteenth, Mr. Didier wired to General Superintendent U. B. Williams,

"After twelve o'clock noon, Monday, the fourteenth, you may resume traffic over bridge eleven. Maximum speed not to exceed four miles per hour until further advice."

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*Abstracted from an article by Robert J. Cole in the "Baltimore & Ohio Employees Magazine." Mr. Cole is editor of the magazine.

†Other information is to the effect that the two middle spans went out first, and the east span later. The east span is the one in Fig. 2, while Fig. 3 shows one of the middle spans lying in the river; the other lay in symmetrical position.—Ed. Engineering News.

As usual he was ahead of the schedule. Here is his own story of the last day:

"Monday morning I got out at daylight and examined every joint myself. At nine o'clock the little yard engine, 1171, ran across, making no impression. The big 2521 followed that; a slight sway could be observed on the bridge, but no variation of track. After we had run fifty-five empties and a coal train over, and I had done everything in my power to avoid accident—safety first you know—No. 14, a passenger train, went over at ten o'clock. This was two hours ahead of the time set."

Forty-four hours were consumed in doing the bent-work proper, all daylight work with only an hour and a half overtime.

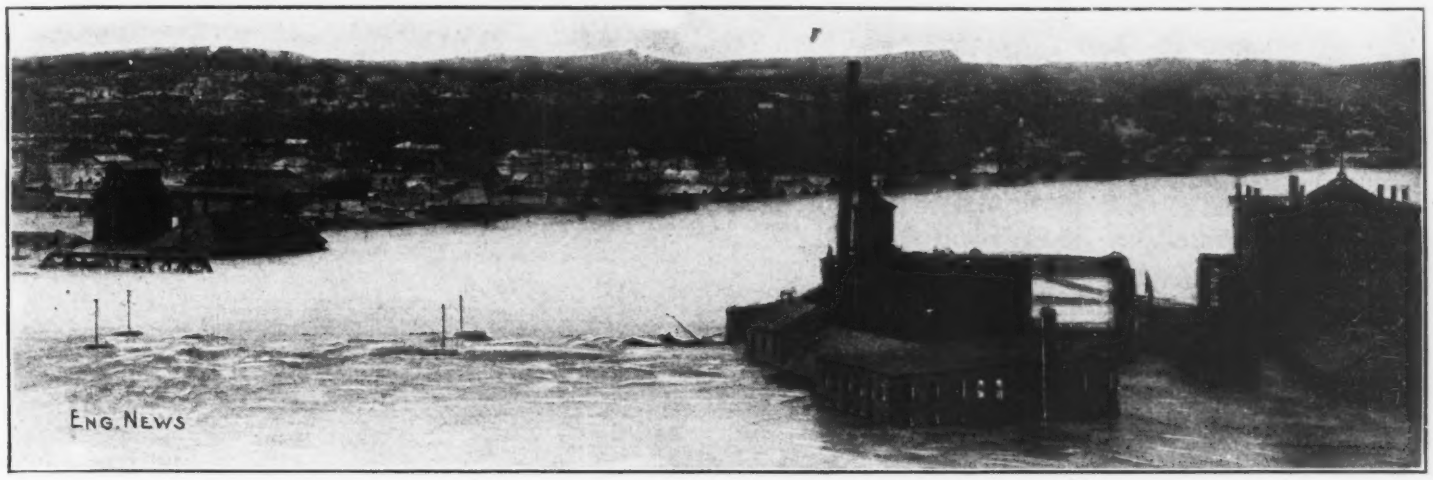

FIG. 1. THE MUSKINGUM AT ZANESVILLE IN THE MARCH FLOOD

(Water had fallen a little below maximum. The ripple marks the Y-bridge. The west span of the B. & O. Ry. bridge is just beyond, nearly submerged, the east three spans already out.)

FIG. 4. THE B. & O. CROSSING RESTORED BY TRESTLE

(One of the carried-out spans at right, nearly as good as new.)

The Failure of the Sand Canon Inclined Pressure Tunnel, Los Angeles, Calif.

BY BURT A. HEINLY*

The dedication of the Los Angeles Aqueduct, which was to have been held on June 18 and 19, has been postponed to sometime early in October as a result of the failure of the Sand Cañon siphon, 150 miles north of Los Angeles. This siphon consists of 1900 ft. of pressure tunnel [in two parts] 9 ft. 2 in. in diameter, driven in hard granite on a 45° incline, connected by 890 ft. of 8½-ft. diameter $\frac{11}{16}$-in. shell steel pipe, the latter extending across the bottom of the cañon. The tunnel was lined with 12 in. of 1:2:4 concrete, poured from the top and was completed in November, 1912. It was under a maximum head of 455 ft.

The failure was due to the giving way of the pressure tunnel on the south side, 100 ft. from the top, with saturation and slippage of the whole side of the cañon wall.

The test of the inclined tunnel began on Saturday, May 24, with a flow of 17 cu.ft. per sec. This was increased to 42 sec.-ft. on Sunday, with the final breakage and the slide taking place twenty hours thereafter.

Some six weeks ago [early in April] the tunnel on the north side of the cañon was tested and showed a leakage 50 ft. beyond the end of the steel at the bottom. This was repaired by putting in 345 ft. of 66-in. diameter ⅜-in. shell steel pipe and at this last test the north side incline showed tight. [We understand that this leak was in a stretch of level tunnel between the inclined tunnel and the original steel pipe.—ED.]

The entire siphon will be rebuilt with steel pipe, for which the order is placed, and should be ready for use in 90 days. The reconstruction is estimated to cost about $40,000.

Sand Cañon is the only pressure tunnel siphon on the aqueduct and was tried as an experiment in rock which was apparently admirable for the purpose. All other siphons have tested satisfactorily.

*636 South Hill St., Los Angeles, Calif.

Annual Meeting of the International Railway Fuel Association

The fifth annual convention was held at the Sherman Hotel, Chicago, on May 21 to 24, with a large attendance. The meeting extended over four days, as sessions were held only in the morning. The chair was taken by the president, H. T. Bentley, Assistant Superintendent of Motive Power, Chicago & Northwestern Ry.

At the opening meeting two addresses were made by representatives of the railways and the coal operators respectively. Mr. Quayle, Superintendent of Motive Power of the Chicago & Northwestern Ry., spoke of the necessity of economic use of fuel in order to save expense and insure efficient operation. Among other matters he instanced the advantages of superheaters on switch engines, not so much to save fuel as to save water, as the engines thus equipped can work for a greater length of time without having to interrupt their work by running to the water tank. Mr. Peabody, President of the Peabody Coal Co., discussed fuel contracts from the coal operator's point of view. He thought that in case of strikes of the miners the railway companies are influential in assisting the miners, as in order to avoid a shortage of fuel they at once demand that the operators shall furnish the maximum amount under their contracts. This results in the railway market absorbing coal which should go to outer markets at such times. In his opinion, the railways should maintain a stock supply sufficient for three or four months, thus avoiding difficulties in time of labor trouble and also using their cars for hauling coal at times when freight traffic is light. The saving in excess cost of coal purchased when high prices rule would more than compensate for the cost of plant and work for storing coal.

Mr. Peabody remarked also that at present only 60% of the coal is removed from a mine, 40% remaining in the pillars left to support the roof. He suggested that it would be cheaper to drive an entry to the extreme limit of the property and then work back, taking out the entire body of coal. In referring to this later, H. H. Stoek (Univ. of Ill.) remarked that this might be an extremely expensive method if it resulted in the surface settlement of valuable land, for which damage the coal operator would have to pay.

A paper on "Sub-Bituminous and Lignitic Coal as Locomotive Fuel," read by S. B. Flagg (U. S. Bureau of Mines), discussed the properties of these coals and described some of the front-end arrangements used to prevent the discharge of sparks from locomotives using such fuels. He stated that there is no doubt the subbituminous coals will be used in increasing quantity, but that there is little probability of marked increase in the use of true lignites. J. G. Crawford (C., B & Q. R.R.) referred to the necessity of special grates and tight ash-pans when burning lignite. The ash-pans must have plenty of air holes, but must be so made that sparks cannot be blown out by the wind. His road uses brick arches in connection with this fuel, although another speaker considered them inadvisable. Mr. Crawford also presented a committee report on a form of contract for the purchase of fuel. Several criticisms of this were made in the discussion.

A paper on "The Construction, Development and Operation of a Bituminous Coal Mine," by J. A. Garcia (Chicago), reviewed the methods of mining, the construction of shafts and tipples, and the screening and handling of coal for shipment. Steel tipples and several forms of wood and concrete lining for shafts were illustrated by drawings. A report on "Firing Practice" led to a protracted discusssion, the members realizing that the firemen (even when mechanical stokers are used) is a most important factor in the efficient and economical use of the fuel supplied. A report on "Scaling of Locomotive Boilers and Resultant Fuel Loss" consisted mainly of extracts from a government publication.

A committee report was presented on "The Modern Locomotive Coaling Station: Its Design, Construction, Operation and Maintenance." It pointed out the necessity of considering local conditions, and also such conditions as the use of mechanical stokers and large tenders. Further, it was recommended that coaling stations should be located at such distance from the terminal as the engines can traverse with one tender-load of coal. The bulk of the report consisted of a summary of a limited number of replies to a series of questions sent out in a circular letter. A subject of a rather different character from most of the papers and reports was "Self-Propelled Railway Passenger Cars." This was presented in a paper by S. F. Dodd and B. H. Arnold (General Electric Co.), which dealt mainly with cars of the gas-electric type. The cost of operation of several of these cars on the Frisco Lines was given as 16.61 to 17.36c. per motor train-mile. It appears, however, that gasoline cars with mechanical drive are much more numerous, but no figures of their operating cost were given.

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The Spring Meeting of the American Society of Mechanical Engineers

The American Society of Mechanical Engineers held its spring convention last week at Baltimore, Md., the first time that this Society has ever met in that city. The attendance at the meeting suffered somewhat on account of the near approach of the international meeting of the Society to be held in Leipzig, Germany, on June 21. Many of the Society members who are planning to go on the foreign tour, sailing from New York on June 10, were unable on that account to attend the Baltimore meeting. There were, however, about 300 members and guests registered at the Baltimore meeting. The chief responsibility for the entertainment of the visitors was undertaken by the Engineers' Club of Baltimore, and great pains were taken to provide the visitors with an attractive program of excursion to manufacturing plants and other objects of interest. At an informal reception in the Hotel Belvidere, on Tuesday evening, the visitors to the city were welcomed in an address by Mayor Preston, of Baltimore, to which response was made by Past-President Oberlin Smith. An interesting address was also made by Mendes Cohen, of Baltimore, who is, with two exceptions, the oldest living Past-President of the American Society of Civil Engineers. Mr. Cohen gave an interesting account of the prominence Baltimore took in the early days of the railway era in the development of transportation routes to the West. He referred also to the great work which the city has undertaken in the construction of a modern sewerage and sewage disposal system and the reconstruction of its pavements.

CODE OF ETHICS—A professional session of the Society opened on Wednesday morning with a short business section. A report was presented at this session by the committee appointed to draft a code of ethics for adoption by the Society. The code which the committee drafted was presented at the December meeting in New York and was printed in the Society's *Journal* for January, 1913, and also in ENGINEERING NEWS of Jan. 2, 1913, p. 29. The committee had invited discussion and criticism of this proposed code and had considered the various criticisms which had been offered. As a result of these criticisms the committee submitted two proposed amendments in the code. The one of principal importance reads as follows:

> The engineer, in conformity to the practice in other professions, should not offer or execute a bond to guarantee the performance of his work. The client's reliance for the satisfactory execution of his work should be the professional reputation and experience of the engineer.

The committee further recommended that in order that the whole membership in the Society might have opportunity to express opinions as to the adoption of the proposed code instead of its being voted on merely by the members present at a meeting, that the proposed code should be printed in pamphlet form and sent out to each member of the Society accompanied by a ballot on which the member might indicate his approval or disapproval of the code, or of any clause thereof. Considerable discussion took place, generally devoted to the question as to whether a code of ethics was desirable at all. It was finally voted, however, to send out the proposed code for letter ballot by the members as recommended by the committee.

THE MYRIAWATT—The special committee on the myriawatt as a standard of power also presented a further report which was discussed at some length. There appears to be confusion in the minds of members as to whether the new unit was to be merely ten kilowatts or whether it was to be chiefly used as a unit of heat transformed into power as in boiler practice.

BLAST FURNACE GAS ENGINES—In the preliminary program of the meeting a separate session had been arranged for the gas-power section on Wednesday morning. As the attendance of members of the gas-power section was too small to make advisable the holding of a separate meeting, the paper by Charles P. Sampson, of the Illinois Steel Works' Joliet plant, on the present operation of gas engines using blast furnace gas as fuel, was read in the main session. Mr. Sampson's paper was a useful compilation of practical experience in the running of blast furnace gas engines. Particular attention was devoted to the modern systems of removing the dust from blast furnace gas before using it in the engines. In the discussion on the paper it was shown that recent German practice has very much reduced the amount of power and of wash water required for cleaning blast-furnace gas.

HYDRAULIC BUFFER—A paper describing a test of a hydraulic buffer was read by Carl Schwartz of the engineering staff of the New York Central R.R. In the equipment of the new Grand Central Terminal, in New York City, there have been imported from Europe some hydraulic buffers, designed to stop a train should it run into a terminal at too high speed. The piston of the hydraulic buffer described has a total travel of 11 ft. The specifications for the buffer required that it should be able to stop without damage a train weighing 1000 tons running against the buffer at a speed of 10 mi. per hr. The test described by the author indicates that the pressure set up in the hydraulic cylinder depends upon the velocity with which the train strikes the buffer and the distance that the plunger travels depends upon the weight of the train.

MECHANICAL DRAWINGS—A brief paper, entitled "Shading in Mechanical Drawing," by Prof. W. Theo. Johnson, professor of mechanical drawing at the U. S. Naval Academy, reviewed the conflicting schemes for shading drawings and recommended a single rule as follows:

> Shade lines mark edges which separate fully illuminated surfaces from surfaces which are quite dark, but the light upon the object comes from a point almost perpendicular to the paper but inclined an infinitely small amount so that the projected direction of light is a 45° line as at present.

The discussion upon this paper was favorable to Prof. Johnson's rule.

PATENT LAW—The present condition of the patent law was reviewed in a paper by Edwin J. Prindle, of New York, with special reference to the decision in the Mimeograph case and the Bath Tub Trust case, and the threatened Congressional legislation as a result. Following Mr. Prindle's paper a resolution was passed for submission to the Council urging Congress to delay any legislation for amendment of the patent law until the whole subject had been investigated by a competent expert commission.

AUTOMOBILE TRUCKS—A paper was presented, entitled "The Cost of Upkeep of Horse-Drawn Vehicles Against Electric Vehicles," by W. R. Metz, of Washington, D. C., superintendent of buildings of the Government Printing Office. The paper gave an array of figures as to the comparative cost of horse-drawn and electric vehicles which showed up with an enormous saving for the electric vehicles. It was pointed out in the discussion, however, that the figures given by the author charged only 2% interest on the investment in electric trucks and 10% depreciation, while the friendless horse was charged 6% interest and 20% depreciation with 15% depreciation on the horse-drawn vehicle and the harness.

HIGH-PRESSURE FIRE SYSTEM—After the luncheon hour on Wednesday the members went to the City Hall Plaza where a special demonstration of the Baltimore high-pressure fire system had been arranged by the city authorities. Six high-pressure fire streams were sent into the air to an elevation variously estimated at 150 to 200 ft., deluging the pavements and the plaza with torrents of water and sending drenching showers of spray down on the heads of the crowd which witnessed the demonstration with every variation in the wind and in the direction of the nozzles. The high-pressure pumping station was next visited. There are now in service in the station three pumping engines with 4000 gal. per min. rated capacity at a piston speed of 300 ft. per min. The engines are of the crank and flywheel type with corliss valve gear. There was some criticism of the design which requires a boiler plant to be kept under steam day and night the year round for a service of only a few hours per year. It was explained, however, that to adopt electricity for driving the station as in the high-pressure pumps in New York City was deemed unreliable because Baltimore receives the bulk of its electric power from the McCall Ferry power plant on the Susquehanna River

10 miles away. Chances for breakdown on this service or on the auxiliary service of the power stations of the lighting and railway companies was felt to be such as to make the installation of steam advisable. From the pumping station the visitors were taken to a steamer and the remainder of the afternoon was spent in a tour of the harbor, inspecting the principal railway and shipping terminals along the water front. On Wednesday evening, Hon. O. P. Austin, Secretary of the National Geographic Society, entertained the members with an interesting lecture entitled "Around the World in Eighty Minutes," an apt illustration of the progress which has been made since Jules Verne's story.

FIRE PROTECTION—The second and concluding professional session of the Society was held on Thursday morning and was devoted to the subject of fire protection, which was felt to be particularly appropriate in view of Baltimore's unfortunate experience of nine years ago. A paper by James D. Scott, of Baltimore, gave a general description of the high-pressure system, which has many points of novelty and interest. F. M. Griswold, of New York City, reviewed the history of the long endeavor to secure a standard hose coupling and hydrant fitting so that the fire department of one city may aid another in case of necessity. For thirty years agitation for the adoption of a standard was practically fruitless. Recently, however, the efforts of the National Fire Protection Association have caused progress to be made so that there are now 73 cities or towns in which the new national standard has been put into service. There is hope, therefore, that the progress of change to the standard from this time on may be rapid.

Albert Blauvelt, of Chicago, discussed the problem of how conflagrations could be prevented from spreading. Mr. Blauvelt pointed out that the hot blast in front of a conflagration when once started prevents any fireman working in front of it. He discussed two plans for the stoppage of conflagrations; (1) their deflection by walls of buildings constructed of fireproof materials with wire glass windows, and (2) the absorption of the conflagration heat by buildings fully sprinkled. The paper gave some interesting data as to the values in congested districts of the principal cities, the cost of complete fire protection against conflagration and the gain which would be made by it.

Prof. Ira H. Woolson, of New York, under the title "Allowable Heights and Areas for Factory Buildings" reported the results of a circular letter of inquiry sent out to all the fire marshals and fire chiefs in the United States in cities of over 20,000 population. A digested summary of all the replies received indicated that for a brick and timber construction a building should not exceed three stories in height with an area of 6000 sq.ft. between firewalls in order that a fire department may cope with it. For such a building if sprinklered or if a fireproof construction and not sprinklered, the height may be increased to five stories and the area between firewalls to from 10,000 to 13,000 sq.ft. A building of fireproof construction fully sprinklered may be seven stories in height as a maximum, with 20,000 sq. ft. of area between firewalls. The chief lesson from Mr. Woolson's paper is that no matter what standards of construction or of fire protection are adopted there is a limit to the height and to the unbroken area to which buildings in cities should be allowed to be erected.

A brief paper by C. H. Smith described how main-belt drives in factories may be prevented from spreading fire from one floor to another by surrounding them with fire retarding partitions made of expanded metal plastered with cement mortar. Under the Associated Factory Mutual Fire Insurance Co., of Boston, with which Mr. Smith is connected, much of this work has been done with great additions to the safety of the factories.

The concluding paper on fire protection, by H. F. J. Porter, of New York, discussed the life hazard in crowded buildings due to inadequate exits. This attracted perhaps, the most interest of any paper of the session. Mr. Porter reviewed, in a graphic way, the great danger to the lives of employees and others in the crowded loft buildings and in the department stores and other structures where great areas are open to aid the spread of conflagration. Mr. Porter urged that in all such buildings at least one fire wall should extend from the basement to the roof, dividing the building into two separate parts. Safety openings through this wall provided with fireproof doors allow the employees from any floor to escape through them to the other side of the fireproof partition immediately a fire starts. This recommendation of Mr. Porter's paper was highly commended in the discussion.

JONES' FALLS COVERING—On Thursday afternoon the visitors were taken on a tour of inspection of the great concrete work which is being done in Baltimore in the covering of the stream which flows through the city known as Jones' Falls, a full description of which is shortly to appear in ENGINEERING NEWS. This trip ended at the pumping station, by which a large part of the city's sewage is forced through a long main to the sewage disposal plant at Back River. Trolley cars from the pumping station conveyed the visitors to the disposal plant. On Thursday evening a reception and dance was given in honor of the Society by the Engineers' Club of Baltimore. The concluding feature of the convention was an all-day excursion on Friday to Annapolis, the capital city of Maryland, and in colonial days a center of wealth, commerce and culture. The visitors met in the fine assembly chamber of the new State Capitol Building, where they were welcomed in an address by Governor Goldsborough of Maryland. Following the Governor's address, Admiral Hutchinson I. Cone, late Engineer-in-Chief of the Bureau of Steam Engineering, U. S. N., delivered an address describing the work of the U. S. Experimental Station at Annapolis. After luncheon at the ancient Carvel House the afternoon was spent in visiting the many points of interest in Annapolis and at the U. S. Naval Academy, visiting the naval vessels in the harbor and witnessing the flight in hydro-aeroplanes by officers and men of the aviation school. Several members of the Society, including its honored president, were treated to rides in an aeroplane and expressed their great delight with the novel experience.

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A Test Load for a Concrete Arch bridge was recently made in England by damming the ends of the roadway and pumping water into the area enclosed. "The Engineer," of London, gives the following account of the test:

A reinforced-concrete bridge comprising an arch of 57-ft. span and decking finished with solid parapets was recently tested under the load of 250 lb. per sq.ft., by building a clay wall at each end and filling the tank so formed with water supplied through a 2½-in. hose pipe. Water can be very easily applied and removed in tests of the kind, and in many cases could be pumped from the river crossed by the bridge to be tested.

A Landslide Wrecked a Train on the Sewell branch of the Chesapeake & Ohio R.R., near Hinton, W. Va., May 20. The train was composed of an engine, three freight cars and a caboose, in which a number of passengers were riding. The train was stalled by a previous slide due to a recent cloudburst, and while the train crew were engaged in clearing the track a second slide occurred which swept the entire train 300 ft. down the mountain side. Six persons were killed and several injured.

The U. S. Torpedo-Boat "Vesuvius" was Struck by Its Own Torpedo while engaged in maneuvers near Newport, R. I., on May 19. Something is reported to have gone wrong with the mechanism of a practice Whitehead torpedo, which caused the projectile to circle around and strike the ship in the stern. A 6-in. hole was knocked through the hull below the water line, but it was sufficiently patched to allow the ship to reach Newport under its own steam. The "Vesuvius" was formerly the famous dynamite cruiser which fired a dynamite-charged bomb by compressed air.

A Derailment on the South Side Elevated Ry., of Chicago, occurred May 24. A southbound train was passing the reverse-curve piece of track in Harrison St., by which the line makes two right-angle turns in getting from Wabash Ave. to the alley west of the avenue, when the front truck of the rear car left the rails. The body of the car projected partly over the structure, but the passengers were able to walk through to the next car. The train was stopped within a very short distance, and little damage was done, but South Side trains could not enter or leave the terminal loops for about half an hour.

The Blowing Out of a Breech Block on a 3-in. gun at Fort Moultrie, Charleston, S. C., caused the death of Capt. B. G. Hanna, U. S. A., and two enlisted men on May 22. The accident occurred about 10 o'clock at night, during night target practice. The type of gun used is known as a field mine gun and is designed to guard a portion of the mine field of the harbor from an enemy's small boats. The accident occurred with a charge of smokeless powder in a metallic container, and is said to have some of the characteristics of a flareback, although exact nature of the breech failure has not been determined. Similar accidents occurred at Fortress Monroe on July 11, 1910, where the cause of the accident was found to be due to firing the gun before the breech mechanism had been locked, and at Indian Head, Md., Nov. 19, 1910, where the gun was prematurely fired due to the firing pin projecting in such a way that it was struck in closing the breech lock.

The New York City Filter Contract Hold-up, to which much space was devoted in our issue of May 22, was made permanent on the same day after the member of the Board of Estimate and Apportionment having the controlling vote announced that he had become convinced that filtration was unnecessary. This member (John P. Mitchell, president of the Board of Alderman), proposed that a new commission of engineers be appointed to consider other means than filtration for the improvement of the Croton water-supply, and suggested the following men for that purpose: Major Cassius E. Gillette, of Philadelphia; Allen Hazen, J. Waldo Smith and George W. Fuller, of New York City; and Harrison P. Eddy, of Boston. This proposition was not adopted. Mayor Gaynor then requested the Commissioner of Water Supply to withdraw his request for the approval of the filter contract award to the lowest bidder (the Keystone State Construction Co.). This having been done, Comptroller Prendergast introduced a resolution rescinding the authorization of bonds for the filtration project and other related work. The resolution was adopted by a unanimous vote.

PERSONALS

Mr. F. H. Hutchison, Electrical Engineer of the Chicago, Rock Island & Pacific Ry., at Chicago, Ill., has resigned.

Mr. Karl J. Barr has been appointed Acting County Surveyor of Edgar County, Ill., succeeding Mr. Carl W. Buckler.

Mr. Robert D. Hennen, of the Monongahela Valley Engineering Co., Morgantown, W. Va., has been appointed City Engineer of Morgantown.

Dr. Edward Thomson Fairchild, former State Superintendent of Schools of Kansas, was inaugurated President of the New Hampshire College of Agriculture and Mechanic Arts on May 21.

Mr. G. C. Cummin has resigned as City Engineer of Dayton, Ohio, to devote his whole time to flood prevention work. Mr. C. H. Kline, Engineer of the water department, has been appointed Acting City Engineer.

Mr. B. J. Denman, Assoc. Am. Inst. E. E., formerly Chief Engineer of the Electric Illuminating Co., of Detroit, Mich., has been appointed Assistant General Manager of the United Light & Railways Co., of Grand Rapids, Mich.

Mr. C. W. Sturtevant, M. Am. Soc. C. E., formerly Superintendent for James Stewart & Co., Baldwinsville, N. Y., is now General Superintendent for the New York State Dredging Corporation, 853 Powers Bldg., Rochester, N. Y.

Mr. J. R. Edwards has been appointed General Inspector of motor cars, reporting to the Engineer of Maintenance-of-way of the Lehigh Valley R.R. He will have general supervision of the maintenance and care of all motor cars.

Mr. M. H. Cahill, recently Superintendent of the Delaware, Lackawanna & Western R.R., at Buffalo, N. Y., has returned to the Baltimore & Ohio R.R. as Assistant Superintendent at Keyser, W. Va., succeeding Mr. J. M. Scott, promoted.

Mr. Burton Lowther, Assoc. M. Am. Soc. C. E., Constructing Engineer of the Water-Works Department, Kansas City, Mo., has been appointed Chief Engineer of Water-Works, succeeding Mr. C. N. Miller, Assoc. M. Am. Soc. C. E., resigned.

Mr. Morgan K. Barnum, General Superintendent of Motive Power of the Illinois Central R.R. and the Yazoo & Mississippi Valley R.R., Chicago, Ill., has resigned. He is succeeded by Mr. Robert W. Bell, Superintendent of Machinery, at Chicago, Ill.

Prof. W. H. Freedman, F. Am. Inst. E. E., head of the department of applied electricity at Pratt Institute, Brooklyn, N. Y., will return in September to the chair of electrical engineering at the University of Vermont, which he occupied until three years ago.

Prof. Sydney W. Ashe, Assoc. Am. Inst. E. E., recently engaged in educational work at the Harrison Lamp Works of the General Electric Co., Harrison, N. J., has been transferred to the Pittsfield works of the same company to engage in similar work.

Mr. J. A. Somerville, Superintendent of Transportation of the Missouri Pacific Ry. at St. Louis, Mo., has been promoted to be General Superintendent of Transportation, succeeding Mr. E. F. Kearney, elected Vice-President of the Texas & Pacific Ry., as noted in our issue of May 22.

Mr. B. F. Cresson, Jr., M. Am. Soc. C. E., who recently resigned as First Deputy Commissioner of the Department of Docks and Ferries, City of New York, has been appointed Engineer of the New Jersey Harbor Commission, with headquarters at 76 Montgomery St., Jersey City, N. J.

Dr. J. S. W. McCullough, Chief Health Officer of the Province of Ontario, Canada, is to be sent to Europe to investigate sewage- and garbage-disposal methods and the prevention of the pollution of water supplies. He will study sewage-disposal methods in Great Britain, France and Germany.

Mr. Richard L. Humphrey, M. Am. Soc. C. E., Consulting Engineer, of Philadelphia, Penn., has been awarded the medal of the Concrete Institute, of London, England, for the best paper read during the 1911-'12 session. Mr. Humphrey is President of the National Association of Cement Users. His paper was entitled "Fireproofing."

Mr. Bela Nagy, Industrial Engineer, formerly with the Davenport Foundry & Machine Co., Davenport, Iowa, the M. Rumely Co., Laporte, Ind., and other manufacturing concerns, has joined the staff of the Samuel Austin & Son Co., Designing and Constructing Engineers, Cleveland, Ohio. Mr. Nagy is a Hungarian and received his education in Vienna and Budapest. He came to this country in 1902.

Mr. Nathan C. Grover, Assoc. M. Am. Soc. C. E., formerly Chief Engineer of the Land Classification Board, United States Geological Survey, has been appointed Chief Hydrographer to succeed Mr. Marshall O. Leighton, M. Am. Soc. C. E., who was recently appointed a member of the Florida State Drainage Commission, as noted in our issue of May 15. Mr. Grover was some years ago Assistant Hydraulic Engineer of J. G. White & Co., New York City.

Mr. Warren C. Earle has been appointed Chief Engineer of the Railroad Commission of California to succeed Mr. R. A. Thompson, M. Am. Soc. C. E., resigned to become a member of the Railway Valuation Board of the Interstate Commerce Commission. Mr. Earle graduated from Northwestern University and has served in the engineering departments of the Northwestern Pacific Ry., the Wabash R.R. and the Chicago & Northwestern Ry.

Mr. Edward A. Crane, M. Am. Inst. Arch., of the firm of Rankin, Kellogg & Crane, Architects, Philadelphia, Penn., has been appointed City Architect of Philadelphia at a salary of $4000 per annum. Mr. Crane was appointed after a civil-

service examination and succeeds Mr. C. B. Zilenzieger, who was recently tried and acquitted for fraud in connection with city contracts. Mr. Crane was Chief of the engineering and drafting division in the office of the Supervising Architect, United States Treasury Department, from 1898 to 1903.

Mr. Archibald Currie, Assoc. M. Can. Soc. C. E., City Surveyor of Westmount, Que., has been made City Engineer of Ottawa, Ont., at a salary of $5000 per annum. Mr. Currie is a Scotchman and a graduate of Glasgow University. He has had experience in China on railway construction and in construction work in South Africa, where he was for a time with the engineering department of the city of Johannesburg. He also served in the city engineering departments of Glasgow and Belfast. Mr. Currie has been City Surveyor of Westmount for the past two years.

Mr. W. G. Comber, Resident Engineer, Pacific division, Panama Canal, has been placed in charge of all dredging operations in connection with the canal work in both the Atlantic and Pacific divisions, and of the dredging work to be very soon begun in the Central division. Mr. Comber is an Englishman who came to this country as a young man and began engineering work as an axman with one of the engineering parties of the Mississippi River Commission in 1883. Here he acquired a thorough knowledge and experience in surveying and in 1892 he was appointed Assistant Engineer in charge of a general survey of the Mississippi River. He began his work at Panama in the summer of 1905 when Mr. John F. Stevens was Chief Engineer, and was successively Resident Engineer at Cristobal, Division Engineer in charge of dredging at Balboa and Resident Engineer in charge of all dredging on the Pacific side.

Dr. David Starr Jordan has resigned as President of Leland Stanford Jr., University, and will become Chancellor, a newly created office. Dr. Jordan is succeeded as President by Dr. John Casper Branner, M. Am. Inst. M. E., Professor of geology and Vice-President of the university since 1899. Dr. Branner graduated from Cornell University in 1874, and received a Ph.D. degree at Indiana University in 1885. For several years following the completion of his course at Cornell he was engaged in work in Brazil, first as Geologist of the Imperial Geological Commission, in mining work and later as Special Agent of the United States Department of Agriculture. Returning to this country in 1882 he became Topographic Geologist of the Geological Survey of Pennsylvania. From 1883 to 1885 he was Professor of geology at the Indiana University, and for seven years following was State Geologist of Arkansas. He went to Leland Stanford, Jr., University as Professor of geology in 1892.

OBITUARY

George D. Rosenthal, District Manager, of the General Electric Co., at St. Louis, Mo., died May 19 in New York City.

Francis M. Rites, M. Am. Soc. M. E., at one time Chief Engineer of the Westinghouse Machine Co., Pittsburgh, Penn., died at his home in Slaterville Springs, N. J., May 8. He was the inventor of the steam-engine governor which bears his name.

George Glover Crocker, Chairman of the Massachusetts Railroad Commission from 1887 to 1892, and Chairman of the Boston Transit Commission 1894 to 1899, died at his home in Cohasset, Mass., May 26. He was born in Boston, Mass., Dec. 15, 1843, and graduated from Harvard University in 1864. He was admitted to the bar in 1867 and since had practiced law in Boston. Besides the offices already referred to he was Chairman of the Joint Board on Metropolitan Improvements, 1909-'10. He was a member of the National Municipal League, the Massachusetts Civil Service Reform Association, the American Association for Labor Legislation and similar organizations.

ENGINEERING SOCIETIES

COMING MEETINGS

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 2-6. Annual convention at Chicago, Ill. Secy., T. C. Martin, 29 W. 39th St, New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 11-13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

OHIO ELECTRIC LIGHT ASSOCIATION.
June 15-18. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
June 16. Semi-annual meeting at Atlantic City, N. J. Secy., Jos. A. Andreucetti, Room 411, C. & N. W. Ter, Sta., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 16-18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

TRAIN DISPATCHERS ASSOCIATION OF AMERICA.
June 17-19. Annual meeting at Los Angeles, Calif. Secy., John F. Mackie, 7122 Stewart Ave., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 17-20. Annual convention at Ottawa, Ont. Secy. Charles Warren Hunt, 220 W. 57th St., New York City.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 20-21. Annual convention at Seattle, Wash. Secy., Jesse A. Jackson, City Hall, Seattle, Wash.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 23-26. Annual convention at Cooperstown, N. Y. Secy., F. L. Hutchinson, 33 W. 39th. St., New York City.

AMERICAN WATER-WORKS ASSOCIATION.
June 23-28. Annual meeting at Minneapolis, Minn. Secy., J. M. Diven, Troy, N. Y.

PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESS.
June 23-28. Congress at London, England. Secy., W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminister, London, S. W.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 24-26. Annual meeting at Minneapolis, Minn. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 24-28. Annual convention at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

CANADIAN ELECTRICAL ASSOCIATION.
June 25-27. Annual convention at Toronto, Ont. Secy., T. S. Young, 220 King St. West, Toronto, Ont.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 25-28. Semi-annual meeting at Boston, Mass. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 17-19. Annual summer meeting at Buffalo, N. Y. Secy., E. A. Scott, 29 W. 39th St., New York City.

INTERNATIONAL GEOLOGICAL CONGRESS.
Aug. 7-14. Twelfth annual session at Toronto, Ont. General Secy., R. W. Brock, Director of Geological Survey of Canada, Ottawa, Ont.

THE TRAVELING ENGINEERS' ASSOCIATION.
Aug. 12-16. Annual convention at Chicago, Ill. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

Conference on the Weights and Measures of the United States—The eighth annual conference was held in Washington, D. C., May 14-17. Papers were read on the "Testing of Gas Meters," by M. H. Stillman, of the U. S. Bureau of Standards; "Testing of Water Meters," by W. F. Stutz, of the U. S. Bureau of Standards; "The Design of Scales," by A. Bousfield, Chief Engineer of the E. & T. Fairbanks Co.; and "Experiments on Scales and Weighing, and Technical Features of Scale Action and Construction," by C. A. Briggs, of the U. S. Bureau of Standards.

American Society of Testing Materials—The Nominating Committee has prepared the following ticket for the election of officers for the ensuing year, to be voted on at or before the first day of the annual meeting, Atlantic City, N. J., June 24-28, 1913:

President: A. N. Talbot, University of Illinois.
2d Vice-Pres: Richard Moldenke, Watchung, N. J.
New members of Executive Committee:
Wm. H. Bixby, John Brunner, F. H. Clark, Albert Sauveur.

The present 1st Vice-President, A. W. Gibbs (Pennsylvania R.R.), remains in office until 1914, as do the four 1914 members of the Executive Committee.

American Institute of Electrical Engineers—At the annual meeting of the Institute, held May 20, the Committee of Tellers reported the following officers elected by letter ballot: President, C. O. Mailloux, of New York; Vice-Presidents, H. H. Barnes, Jr., of New York, J. A. Lighthipe, of Los Angeles, Calif., C. E. Scribner, of New York; Managers, B. A. Behrend, of Boston, Mass., Peter Junkersfeld, of Chicago, Ill., H. A. Lardner, of San Francisco, Calif., and L. T. Robinson, of Schenectady, N. Y.; Treasurer, G. A. Hamilton, of New York. It was announced that, at the recent meeting of the Board of Directors, F. L. Hutchinson had been reappointed secretary.

The report of the Board of Directors made at this meeting showed a total membership of 7654, a gain of 195 during the year. The number is divided into five honorary members, 316 fellows, 847 members, 6486 associates. The cash receipts of the year were given as $112,982 and the total disbursements as $119,186. The total assets were placed at $683,036, while the liabilities, including mortgage on the joint societies building, current liabilities and special funds amount to $89,852.34.